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PARACHUTE RIGGER 1 & C

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10360-A

PREFACE

This Navy Training Course is one of a series of training courses prepared for enlisted personnel of the Navy and of the Naval Reserve who are studying for advancement in the Parachute Rigger rating.

As indicated by the title, this training course is based primarily on the professional qualifications for the rates of PR1 and PRC, as set forth in the *Manual of Qualifications for Advancement in Rating*, NavPers 18068. These qualifications, current as of the date of Change 19 to the "Quals" Manual, are listed in appendix II of this book.

Combined with the necessary practical experience and a thorough knowledge of the material contained in *Parachute Rigger 3 and 2*, a study of the material in this course will greatly assist the PR2 and PR1 in preparing for advancement. This training course should also be valuable as a review source for the PRC who is studying for advancement to PRCS and the PRCS in studying for PRCM.

This training course was prepared by the U. S. Navy Training Publications Center, Memphis, Tennessee, in conjunction with the Training Division of the Bureau of Naval Personnel. Technical assistance was provided by the Bureau of Naval Weapons and by the Parachute Rigger Schools, NATTU, Lakehurst, New Jersey.

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DOCUMENTS

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	† E7 to E8	‡ E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6.	48 mos. as E-7. 8 of 11 years total service must be enlisted. Must be permanent appointment.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.	▨	Class A for PR3, DT3, PT3. ǂ AME 3	▨	▨	Class B for AGCA, MUCA, MNCA.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 760, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST	▨		Specified ratings must complete applicable performance tests before taking examinations.				▨	▨
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS	Locally prepared tests.		Service-wide examinations required for all PO advancements.				Service-wide, selection board, and physical.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)	▨	Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		
	TARS are advanced to fill vacancies and must be approved by CNARESTRA.							

* All advancements require commanding officer's recommendation.
† 2 years obligated service required.
‡ 3 years obligated service required.
ǂ Effective 1 Jan. 1963.

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INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	FOR THESE DRILLS PER YEAR	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	48	6 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	48 mos.	24 mos.
	24	9 mos.	9 mos.	15 mos.	18 mos.	24 mos.	36 mos.	48 mos.	24 mos.
	NON-DRILLING	12 mos.	24 mos.	24 mos.	36 mos.	48 mos.	48 mos.		
DRILLS ATTENDED IN GRADE †	48	18	18	45	54	72	108	144	72
	24	16	16	27	32	42	64	85	32
TOTAL TRAINING DUTY IN GRADE †	48	14 days	14 days	14 days	14 days	28 days	42 days	56 days	28 days
	24	14 days	14 days	14 days	14 days	28 days	42 days	56 days	28 days
	NON-DRILLING	None	None	14 days	14 days	28 days	28 days		
PERFORMANCE TESTS		▨	▨	Specified ratings must complete applicable performance tests before taking examination.					
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)		Record of Practical Factors, NavPers 760, must be completed for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Completion of applicable course or courses must be entered in service record.							
EXAMINATION		Standard exams are used where available, otherwise locally prepared exams are used.						Standard EXAM, Selection Board, and Physical.	
AUTHORIZATION		District commandant or CNARESTRA					Bureau of Naval Personnel		

* Recommendation by commanding officer required for all advancements.
† Active duty periods may be substituted for drills and training duty.

THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

Parachute Rigger 3 and 2, NavPers 10358-A
Safety and Survival Equipment for Naval Aviation, NavAer 00-80T-52
Parachute Manual, NavAer 13-5-501
Parachute Manual Supplement, NavAer 13-5-501A
Survival Training Guide, NavWeps 00-80T-56
Space Training Unit, NavAer 00-80T-71

CHAPTER 1

THE PARACHUTE RIGGER RATING

RESPONSIBILITIES OF THE PR1 AND PRC

As a petty officer, you are already aware of the importance of your rating to the Navy. Since the day you became a PR striker, your primary responsibility has been that of saving lives. You are well aware that without the services performed by the men of the PR rating none of the Navy's air operations could be safely conducted, and with today's high-speed, high-altitude aircraft, the Parachute Rigger's job is more important than ever before.

As higher and higher aircraft speeds and altitudes are attained, new items of flight and protective clothing and survival equipment are developed. Thus, the Parachute Rigger's job involves more and more responsibilities; and from the lowest level up, he must possess greater technical skills than ever before.

When advanced to PR1 or PRC, even more responsibilities are to be yours. As a senior Parachute Rigger, you must possess more than technical skills. You must assume greater responsibility, not only for your work but also for the work of others who serve under you. Briefly, the senior Parachute Rigger must be a master technician, military leader, supervisor, inspector, and instructor.

As a PR1 you must be qualified to assist the flight surgeon in fitting and adjusting anti-g suits; maintain and test pressure suits and related equipment; operate and maintain oxygen transfer equipment; shop test liquid oxygen converters and repair or replace components as necessary; test oxygen for contamination; test and maintain oxygen regulators; and maintain carbon dioxide recharge equipment. In addition, the PR1 must maintain records, prepare reports, and inventory and order equipment, spare parts, and other materials. Finally, the PR1 must be capable of taking charge in the absence of the PRC.

As a PRC you must be qualified to fit and modify oxygen masks; prepare calibration and flow charts for testing oxygen regulators and converters; maintain regulator test stands and liquid oxygen converter test stands; demonstrate aircraft emergency escape procedures; assemble, pack, and rig airdrop survival kits and containers and construct various types of lift webs and sling assemblies. In addition, the PRC must be fully qualified to organize and administer a parachute loft; plan, schedule, and direct work assignments; and maintain quality control of all work performed.

The preceding is a brief summary of the requirements for advancement to First Class and Chief Parachute Rigger. Detailed requirements are listed in appendix II of this book.

ASSIGNMENTS AVAILABLE TO PR1 AND PRC

As a senior Parachute Rigger, a wider variety of assignments will be available to you. In addition to the various types of maintenance activities to which lower rated PR's are assigned, senior PR's are eligible for assignment to various experimental and test facilities, as well as a number of billets under the management control of the Bureau of Naval Personnel.

Parachute Riggers are assigned to experimental and test facilities to assist in the work of testing and evaluating newly developed items of equipment. These units determine the suitability of equipment prior to its use in the fleet. Examples of such units are the Navy Parachute Experimental Division at El Centro, California, and the Air Crew Equipment Laboratory at Philadelphia, Pennsylvania.

Most of the billets under the management control of the Bureau of Naval Personnel are directly associated with training. Some of those available to senior Parachute Riggers are described below. Others are announced from time to time in the form of series 1300 BuPers Instructions.

Instructor billets are available to both the PR1 and PRC in the PR Schools, located at NATTU, Lakehurst, New Jersey. Instructor billets are normally filled on a voluntary basis. Personnel selected from the volunteer list are first sent to Instructor School at NATTC, Memphis, Tennessee, for a 4-week course in instructor training.

PRC's are eligible for assignment to the Navy Training Publications Center at Memphis, Tennessee, as technical advisors. Technical advisors assist in the preparation and revision of Navy Training Courses and other training materials.

Another billet available to PRC's is with the Naval Examining Center at Great Lakes, Illinois, as item writer. In this billet, PRC's assist in the preparation of servicewide advancement-in-rate examinations for the PR rating.

REFERENCES USED IN PREPARING FOR ADVANCEMENT

Manual of Qualifications for Advancement in Rating, NavPers 18068 (Revised)

The *Manual of Qualifications for Advancement in Rating*, commonly referred to as the "Quals" Manual, is the official publication which sets forth the minimum qualifications for advancement in rating of all enlisted personnel in the Navy. The "Quals" Manual serves as a guide for (1) enlisted men in preparing for advancement in rating, (2) preparation of training courses and school curricula, and (3) preparation of servicewide advancement-in-rating examinations. The manual is kept up to date to meet the needs of the Service by CHANGES TO THE MANUAL, issued periodically by the Bureau of Naval Personnel.

The "Quals" Manual is composed of two main sections, titled Military Requirements and Professional Qualifications.

MILITARY REQUIREMENTS.—This section contains those generally applicable qualifications which all enlisted personnel are expected to demonstrate as a minimum for advancement to specific pay grades. They are applicable to all personnel at the specified pay grade except where indicated for men or women only.

The military requirements are broken down into practical factors and examination subjects. Candidates for advancement in any pay grade must demonstrate proficiency in the practical factors specified for the next higher pay grade, and may be required to demonstrate those for all lower pay grades. Knowledge essential to performance of the practical factors as well as those essential to the required examination subjects are subject to examination for advancement.

PROFESSIONAL QUALIFICATIONS.—This section contains the professional requirements for advancement in each rating. The professional qualifications for the Parachute Rigger are broken down into subject matter areas, and each subject matter area is further broken down into practical factors and knowledge factors. Practical factors must be completed before recommendation for participation in the servicewide examinations. Knowledge factors and knowledge aspects of the practical factors form the basis for questions in the written advancement examinations. Qualifications for a higher rate include the qualifications of the lower rate or rates in addition to those stated for the higher rate.

The professional qualifications for the Parachute Rigger rating are listed in appendix II of this training course, current as of the date of Change 19 to the "Quals" Manual. Before using these qualifications as a guide in studying for advancement, always make sure that no further changes affecting the PR rating have been issued. If in doubt, check the official copy of the *Manual of Qualifications for Advancement in Rating* in your education office.

Record of Practical Factors

A standard method of maintaining a record of each enlisted man's progress on the practical factors of his rating was established with the issue of BuPers Instruction 1085.38. As directed by this Instruction, an appropriate *Record of Practical Factors*, NavPers Form 760, is to be maintained by each command for each enlisted man in pay grades E-3 through E-8.

Completion of the practical factors for the rate to which the man is advancing is required prior to actual participation in the servicewide examination. As proficiency in each practical factor listed on the form is demonstrated, an entry is made in the "Date" and "Initials" columns of the form by the supervising officer.

All factors for which facilities are available must be completed by actual demonstration. At commands where facilities are not available for proper demonstration of certain practical factors, personnel may be qualified in those factors by local written examinations.

If a man demonstrates proficiency in skills considered to be within the scope of his rating but not listed in the list of minimum qualifications, an appropriate entry is made on his form.

One copy of this form is to be held by the division officer or by the appropriate supervising officer of each man in pay grade E-3 through E-8. Upon transfer, the supervising officer's copy of the form is signed, inserted in the correspondence side of the man's service record, and forwarded.

As changes in the rating structure and major changes in the ''Quals'' Manual occur, new forms are made available. Minor changes in the ''Quals'' Manual are recorded on existing forms in the spaces provided.

One copy of the printed form is made available to each man for his personal record and guidance.

Training Publications for Advancement in Rating NavPers 10052

A publication titled *Training Publications for Advancement in Rating*. NavPers 10052, lists Navy Training Courses and other reference materials required or recommended for study in preparing for advancement in each of the enlisted ratings.

This booklet is revised and reissued annually by the Bureau of Naval Personnel and is the official bibliography of reference sources from which advancement-in-rating examination questions are taken. In using the booklet, remember that training courses which are marked with an asterisk (*) must be completed by passing the Enlisted Correspondence Course based on that training course, or by passing a locally prepared and administered test.

List of Training Manuals and Correspondence Courses, NavPers 10061

Another valuable reference source is the publication titled List of Training Manuals and Correspondence Courses, NavPers 10061. This booklet is an alphabetical listing (catalog) of all types of training publications, both officer and enlisted.

NavPers 10061 is revised and reissued semiannually and includes the following alphabetical listings: All Training Manuals, Enlisted Correspondence Courses, and Officer Correspondence Courses.

Preceding the list of Enlisted Correspondence Courses is a section on the Enlisted Correspondence Program which outlines the program and gives detailed instructions for making application for enrollment.

NavPers 10061 is distributed to all ships and stations, and the latest edition is always available in your I and E office.

Navy Training Courses

Navy Training Courses are of three general types, each designed to aid the enlisted man in preparing for advancement in rating. They are classed as General Courses, Basic Courses, and Rating Courses.

GENERAL COURSES.—General courses cover the military requirements specifically required of all petty officers. Included as mandatory reading in this group are *Military Requirements for Petty Officer 1 & C*, NavPers 10057, and *Military Requirements for Petty Officer 3 & 2*, NavPers 10056. Certain chapters of several other general courses are listed as recommended reading. For this listing, refer to the current edition of *Training Publications for Advancement in Rating*, NavPers 10052.

BASIC COURSES.—These courses are sometimes referred to as subject matter courses. They cover such fundamental subjects as blueprint reading, mathematics, handtools, basic electricity, hydraulics, and the like. In other words, subjects which are useful to more than one rating are covered in this group. Among those of interest to the Parachute Rigger are *Blueprint Reading and Sketching*, NavPers 10077-A, and *Basic Hand Tool Skills*, NavPers 10085.

RATING COURSES.—Rating courses cover the professional qualifications for a specific rate or rates, using the ''Quals'' Manual as a guide. This means that each qualification in the ''Quals'' Manual (practical factor and knowledge factor) is covered either by adequate material in the rating book itself, by reference to a basic course, or by reference to some other satisfactory and readily available publication.

Rating courses are revised from time to time to keep pace with new developments in equipment as well as to comply with changes to the rating structure in the ''Quals'' Manual. In studying for advancement, always check the current edition of List of Training Manuals and Correspondence Courses, NavPers 10061, for the date of the latest issue of your rating course or courses.

This Training Course

This training course is based on the professional qualifications for the rates of PR1 and PRC, as set forth in the "Quals" Manual (effective as of the date of Change 19). It is designed primarily for use by the PR2 who is studying for advancement to PR1, and the PR1 who is studying for PRC. Much of the material in this course should also be valuable as a review source for the PRC who is studying for advancement to PRCS and the PRCS in studying for PRCM.

Chapter 2 deals mainly with the administrative duties of the PRC; for example, setting up and organizing a parachute loft; procurement of materials and equipment maintenance of records and reports; procurement and use of aeronautical publications; and training of loft personnel.

Chapter 3 covers survival and air-sea rescue equipment and is intended primarily for the PRC who is responsible for instructing pilots and aircrewmen in the proper use of such equipment.

Chapter 4 deals with sewing machine repair, covering timing and other adjustments made on the most commonly used models. Chapter 5 covers various types of nonpersonnel parachutes.

Chapter 6 describes the Mk IV Full Pressure Suit, along with the procedure for donning, doffing, testing, and maintaining the suit and related equipment. Various other items of personal equipment are also covered in this chapter.

The next 5 chapters are devoted to oxygen handling and testing and the various types of oxygen equipment the PR is responsible for maintaining. The final chapter covers maintenance of carbon dioxide transfer equipment.

Suggestions for Studying

Here are some ways that have been found to be effective by men studying Navy Training Courses for advancement.

Start by reading the preface, table of contents, and index. Then thumb through the entire book, looking at the illustrations and reading bits here and there as your eyes fall on something interesting. This browsing will show you how the book is organized and the subject matter it covers.

Next preread the entire course. Do this to learn the relationship of parts and chapters to the whole of the rating covered in the course. Read the introductions to each chapter. Then read the headings and subheadings. Ask yourself such questions as: What do I already know about this particular topic? How are these topics interrelated? What am I expected to know about this process or technique?

Learn the qualifications for advancement in your rating (in appendix II). You are studying the NTC in order to meet these "Quals."

These preliminary steps orient you and help you plan your study. They put you in a better position to draw on personal experience and to relate your past experience to the new material.

After this preliminary work you are ready to fill in the details by intensive study of the chapters, sections, and subsections. What you can cover during a study session depends on (1) the difficulty of the material; (2)what you already know about the topic; and (3) your skill as a reader. At any rate, for each study session plan to master a predetermined unit of material: an entire chapter or a major section of a chapter.

Use the PREREADING system with each section and paragraph. Skim the introduction, headings, first and last sentences of each paragraph, and all summarizing statements. As you preread, think up questions about the material. Write down these questions for future reference. Another useful technique is to make an outline during prereading, filling in the details later. When you have finished prereading, think about what you have learned thus far. Ask yourself such questions as: What main ideas are presented? What details must I look for?

Next, read the entire chapter or section completely and carefully. As you read, be on the lookout for the questions you have thought about or the details of your outline. Relate the part to the whole. Relate your previous knowledge and background experience to the discussion. Identify yourself with the situations, processes, and techniques; visualize yourself doing the things that are described.

Recite what you have learned. This is the proof of understanding. Look at the questions you wrote down during prereading. Do you know the answers? Try to master the material you are studying before proceeding to a new portion of the text.

CHAPTER 2

PARACHUTE LOFT ADMINISTRATION

PARACHUTE LOFT AFLOAT

The CVA parachute loft, like most of the other shops afloat, is extremely limited in size. In order to accomplish the vast amount of work that flows through an establishment of this kind, everyone concerned must cooperate by adhering to a well-planned schedule.

The greater portion of the space provided is occupied by three main items—packing tables, storage bins, and sewing machines. Modern carriers have an additional space provided for airing and drying parachutes. The justification for this drying space was linked to the need for a more adequate packing schedule. Before this added space for drying parachutes was incorporated, parachutes due to be packed were hung in the inadequate loft space. This jammed the packing schedule to such an extent that the air group squadrons were unable to pack their parachutes during the allotted time. A dry locker permits the parachutes to be cleared out of the loft, allowing a round-the-clock packing schedule when necessary. Figure 2-1 illustrates the physical layout of a typical parachute loft space located on the 02 deck of a CVA type carrier. Air groups using this space are required to help in its maintenance while they are aboard.

Small carriers have very limited facilities aboard for parachute packing. The Parachute Rigger in charge has three alternatives with which to meet the packing schedule: Messhall tables can be utilized for packing, a lightweight plywood sectional packing table can be set up in some clear part of the ship, or shore establishment packing facilities can be used whenever possible. Parachutes and survival equipment are stowed in lockers throughout the ship. There is no assigned working space large enough to carry out the everyday working schedule. The duty aboard a small carrier may be classified as a field operation that demands more of a Parachute Rigger's ingenuity than can be related here.

PARACHUTE LOFT ASHORE

The design and style of the parachute loft ashore vary from activity to activity, depending upon the mission of the station. Figure 2-2 illustrates one of the many floor plans of a typical parachute loft.

Parachute Packing Section

The parachute packing section is devoted to packing and inspecting parachutes. Parachute packing tables naturally occupy the greatest part of the loft. Thorough consideration should be given to the number of tables that can be successfully utilized, allowing ample working space around the tables.

A cutaway table is the least tiring to use, as the packers do not have to stretch across its full width during the closing and finishing of the packing. Figure 2-3 shows the cutaway packing table. The dimensions shown in this illustration are adequate for accommodating the 28-foot service parachute. The tension device for the packing table is extremely simple to make. These devices should be constructed to suit the individual packing needs.

STORAGE BINS.—Storage bins should be constructed so there is enough clearance between the shelves and the sides to allow for easy insertion and removal of parachutes with liferafts attached. The bins should be long enough for the parachutes to be placed on a shelf side by side with at least 1 inch clearance on all sides and top. The bottom row of bins should be located at least 12 inches from the deck and all bins 4 inches away from the bulkhead.

WORKLOAD.—A reasonable maximum workload per day for one table is considered to be approximately 25 parachutes. The number of air groups, the parachutes assigned each, and the station equipment will have to be taken into consideration in order to determine the number of tables necessary to adequately carry out the prescribed packing schedule. Many factors

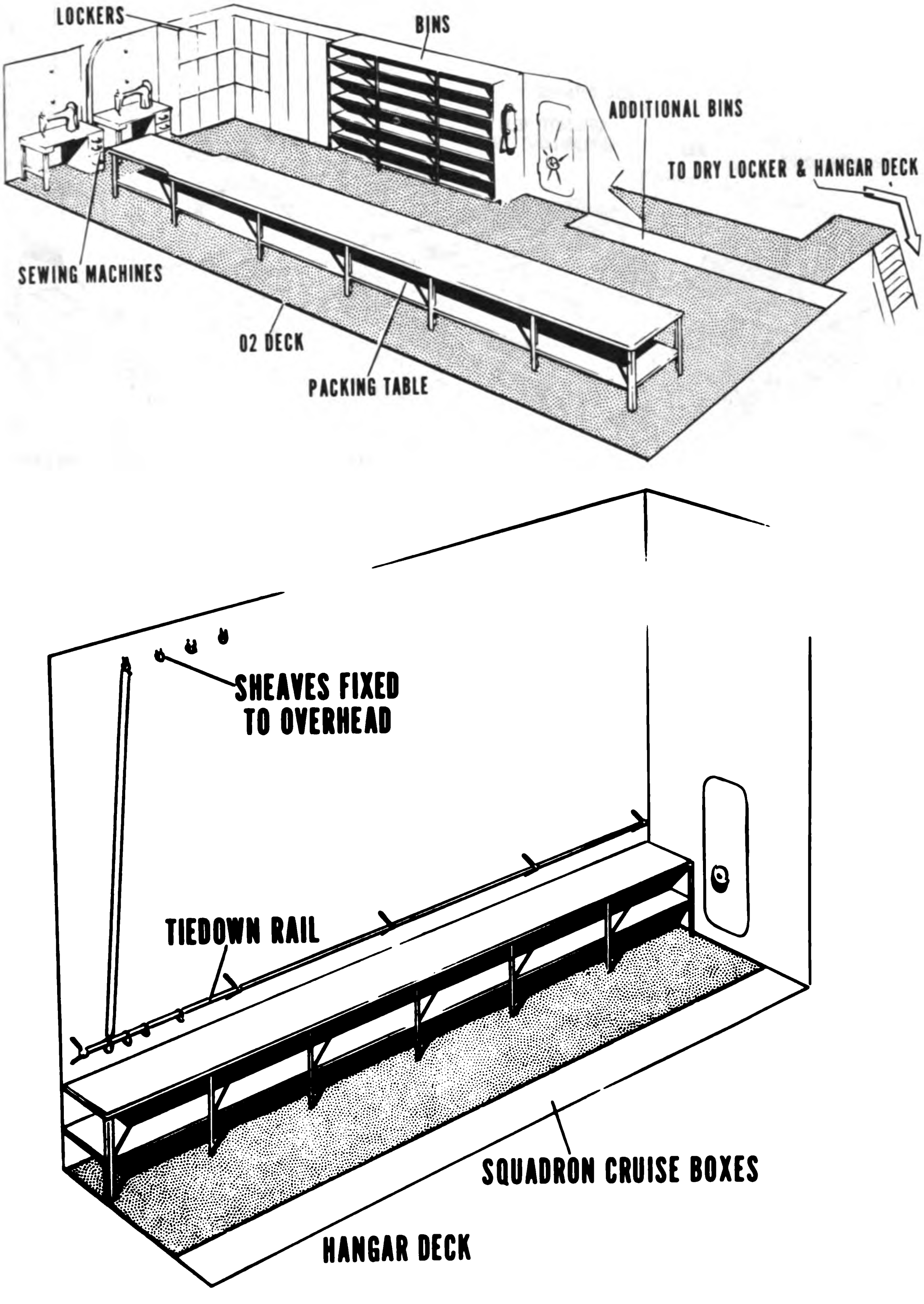

Figure 2-1.—Parachute loft space aboard an aircraft carrier.

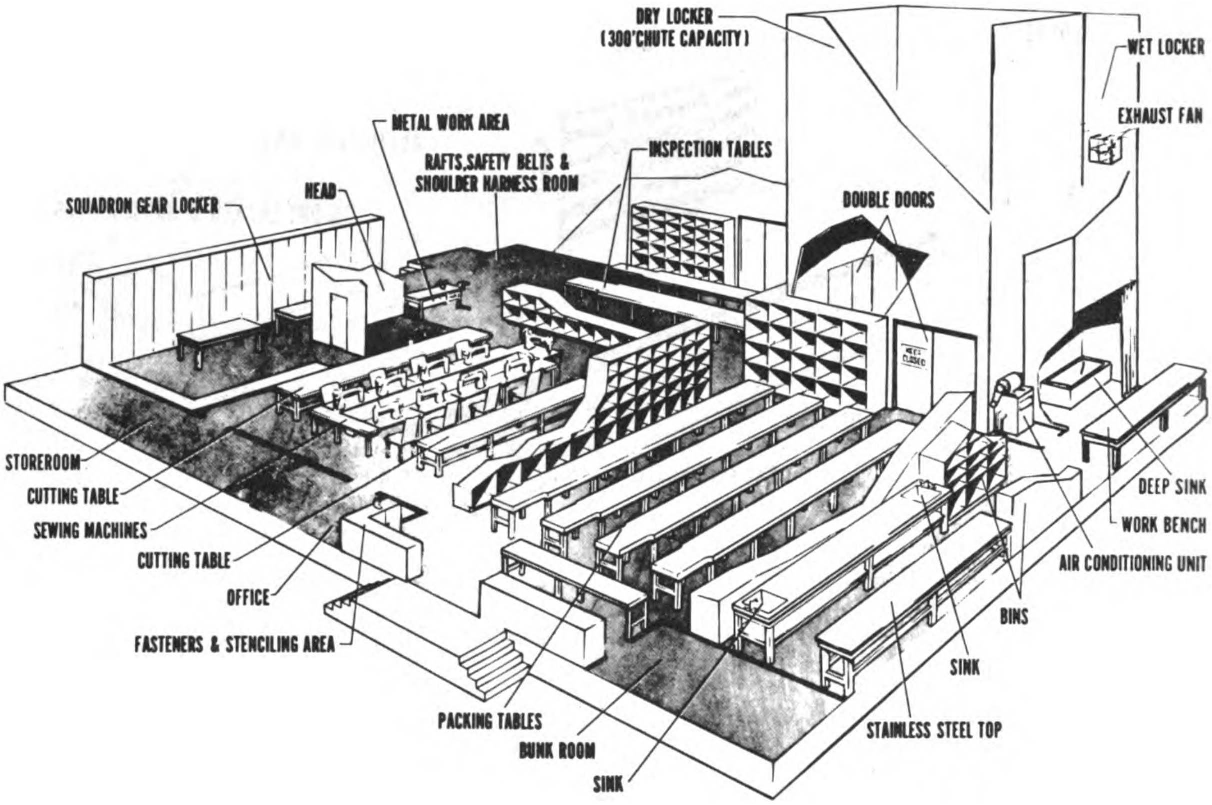

Figure 2-2.—Floor plan for a parachute loft ashore.

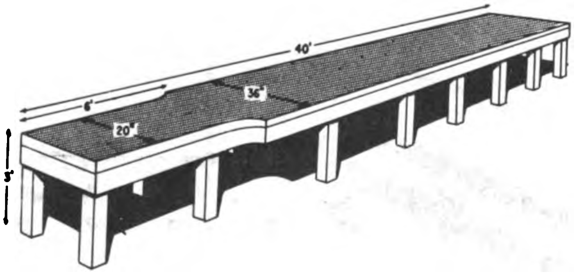

Figure 2-3.—Cutaway packing table.

determine the workload of a parachute loft. Packing operations should not be interrupted and the area where the tables are located should be kept free of traffic. Spacing the tables at least 3 feet apart and parallel to each other provide the best arrangement. More room is needed at the foot of the tables than at the heads, where very little activity takes place.

Lighting the parachute loft is very important. It takes good eyes and good lighting to find stitching irregularities and ruptures in glossy white material. Fluorescent lighting has been found to be best, as it gives a flat light bright enough for packing, inspecting, and sewing machine work.

MAINTENANCE.—The general maintenance of the packing section involves little more than keeping the spaces cleaned and waxed. Every effort should be made to keep all surfaces and edges of the packing tables smooth and free of splinters to prevent snagging the parachute canopy and lines.

AIR CONDITIONING.—For best results, if at all possible, the parachute loft packing spaces should be air conditioned. After the parachutes leave the dry locker they are rigged and packed for immediate use. The loft is usually a large unconfined area. Doors opening and closing present air-conditioning problems. If it is at all possible, the temperature and humidity range should be that of the dry locker and not on a par with unpredictable outside conditions.

Controlled temperature and humidity prevent excessive dampness or dryness of the canopy material. Excessively dry cloth is more likely to generate static electricity. If a parachute is packed under conditions conducive to the production of static electricity, the electricity is packed along with the canopy. If this parachute should be jumped on a cold dry day, it may open rather slowly. The static electricity causes the folds of the canopy to cling to each other and may even be responsible for a streamer.

Dry Locker

The most important section of a parachute loft is the dry locker, or the drying tower, as it is sometimes called. This structure is used to condition the parachutes for packing. The height of the dry locker is determined by the length of the parachute from the peak to the ends of the leg straps on the NS-3 or NC-3 parachute. A 28-foot parachute, suspended freely, requires a height of approximately 45 feet.

PARACHUTE SUSPENSION.—The methods used to suspend a parachute vary slightly, depending on the number of parachutes handled daily, available hardware, and the space available to properly space the hoisting lines for adequately drying and airing the parachute. Figure 2-4 illustrates 3 methods of suspending a parachute and the equipment involved. For adequate drying of parachutes, the hoisting lines should be a minimum of 2 feet apart.

The hoisting lines used to suspend parachutes must be free from harmful agents containing tars and oils. Braided cotton lines are the most flexible and best adapted for this purpose. Hardware used in constructing the hoisting lines, especially those coming in contact with the canopy, must be free from burrs and sharp edges.

LIGHTING.—Flush type lighting fixtures are the safest to use in dry locker construction since the material of the parachute could easily be damaged if it touched an exposed hot lamp. If an insufficient number of these flush type lighting fixtures are used, the resultant lighting will be very poor. Except for hanging and lowering the parachutes, there is little need for real bright lights. To supplement inadequate lighting from too few of the flush type lighting fixtures, a fluorescent lamp that generates little heat may be installed on the surface of the wall or on the overhead. Some means of climbing up the inside of the dry locker should be provided to enable personnel to service the hoisting lines and lighting fixtures.

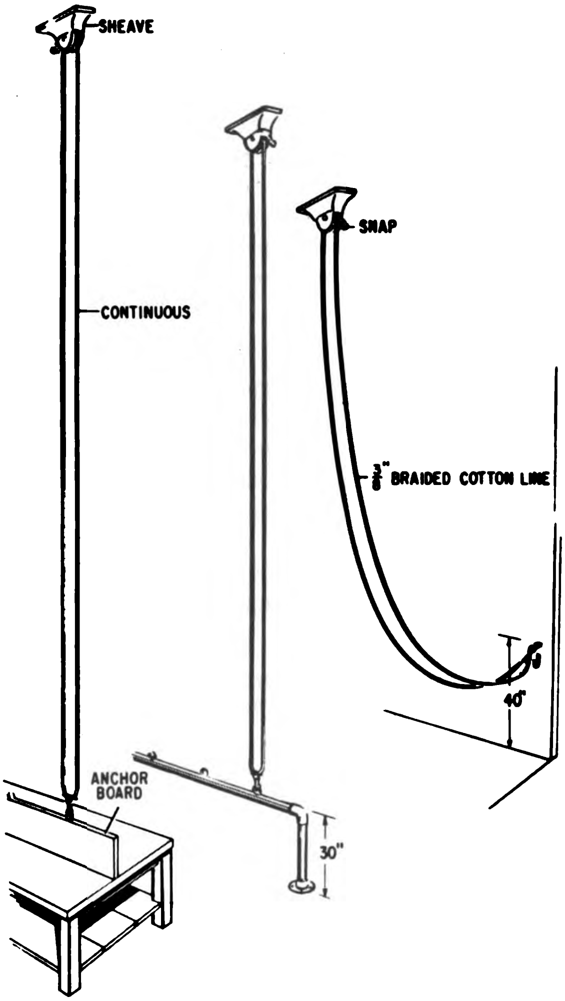

Figure 2-4.—Parachute suspension methods.

TEMPERATURE AND HUMIDITY CONTROL.—Every dry locker should be air conditioned with a unit capable of maintaining the recommended temperature and humidity range.

Humidity control is even more important than temperature, since dampness causes mildew in fabrics. The dehumidifying accomplished by the air-conditioning unit can reduce the moisture content of the air considerably. If the air-conditioning unit fails to decrease the humidity, a dehumidifier should be placed in the dry locker to supplement the air conditioner and bring the humidity down to the proper limits.

Difficulty may be experienced in keeping dry locker humidity within proper proportions during tropical rainy seasons in some areas, regardless of the extent of air-conditioning facilities. Under such conditions, magnesium chloride, a chemical which absorbs moisture in the air, will be very useful.

Set up a number of cheesecloth nets about 2 feet square and suspended at each corner approximately 2 feet from the deck. Place several handfuls of magnesium chloride in each net and provide drip pans under each net for catching the water. When the chemical has absorbed and shed a considerable quantity of water, it has a tendency to solidify. It must then be broken up so as not to impede its absorbing effects.

The temperature and humidity of the dry locker must be frequently checked if a reliable drying schedule is to be effected. There are various instruments applicable to recording temperature and humidity. Temperature and humidity ranges are shown in table 2-1.

Table 2-1.—Parachute loft temperature and humidity ranges.

Location	Range	Temperature	Relative humidity
Dry locker. .	Ideal	70° F.	40%
	Safe average . .	60° to 85° F.	30% to 60%
Storage. .	Ideal	70° F.	40%
	Safe average . .	60° to 75° F.	30% to 60%
Packing loft . . .	Ideal	70° F.	60%
	Safe average . .	60° to 85° F.	30% to 60%

NOTE: The maximum temperature for any space is 110° F.

SLING PSYCHROMETER.—A psychrometer is an instrument used for measuring the amount of water present in the atmosphere. The instrument consists of a wet-bulb and a dry-bulb thermometer.

As the water evaporates from the wick around the wet bulb, it is cooled, giving a lower reading than that of the dry bulb. The faster the water evaporates, the lower the reading on the wet-bulb thermometer. If no evaporation occurs, both thermometers will give the same reading, which means the air is saturated. Knowing both wet- and dry-bulb temperatures, the absolute and relative humidity may be easily determined from prepared charts accompanying the instrument.

The sling consists of a wooden grip with a swivel head and harness type spring clip for attaching to the top hole of the psychrometer frame. For checking humidity, use a clear, open space, preferably exposed to the wind. Rotate the instrument with a wrist motion for best results. The whirling should be approximately 120 r.p.m. Bring the instrument to a stop without any sharp jar, lift it to eye level, and read both thermometers to the nearest tenth of a degree, reading the wet bulb first. The whirling is repeated and other readings are made until the wet-bulb temperature fails to show further decline.

Calculate the difference between the dry-bulb and the wet-bulb temperature readings. After the difference is obtained, based on the barometric pressure nearest the normal atmospheric pressure, the next step is to enter the readings on the tables. The tables are found in the U.S. Weather Bureau Publication No. 235. The dry-bulb temperature is given in the vertical column at the left of the table, and the depression of the wet bulb printed across the top of the table. Dewpoint and relative humidity data are given as tabular values on correspondingly captioned pages.

For example, suppose the barometric reading is 30 inches of mercury, the dry-bulb temperature is 69° F., and the wet-bulb temperature is 61° F. As shown in table 2-2, the left-hand column is headed AIR TEMPERATURE, which is dry-bulb temperature and is in degrees Fahrenheit. The other columns are headed DEPRESSION OF WET-BULB THERMOMETER. This depression is the difference in the readings at the wet- and dry-bulb thermometers. In this

Table 2-2.—Relative humidity, percent-Fahrenheit temperatures. Portion of U.S. Weather Bureau Publication No. 235.

Air temperature	Depression of wet-bulb thermometer														
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
65	90	87	85	82	80	77	75	72	70	68	66	63	61	59	56
66	90	87	85	82	80	78	75	73	71	68	66	64	61	59	57
67	90	87	85	83	80	78	75	73	71	69	66	64	62	60	58
68	90	88	85	83	80	78	76	74	71	69	67	65	62	60	58
69	90	88	85	83	81	79	76	74	72	70	67	65	63	61	59
70	90	88	86	83	81	79	77	74	72	70	68	66	64	61	59
71	90	88	86	84	81	79	77	75	72	70	68	66	64	62	60
72	91	88	86	84	82	79	77	75	73	71	69	67	65	63	61
73	91	88	86	84	82	80	78	75	73	71	69	67	65	63	61
74	91	89	86	84	82	80	78	76	74	71	69	67	65	63	61

example, the depression is 69 minus 61, or 8° F. Locate 69° F. in the left-hand column. Follow horizontally to the right on this line to the column headed 8.0. Now, read the value of the relative humidity, which in this case is 63 percent.

HYGROTHERMOGRAPH.—The humidity element of the hygrothermograph, the standard instrument for the measuring and recording of relative humidity and temperature, consists of separate strands of the best grade natural blond human hair, about 50 strands in all, spread into 8 groups. The hair element increases in length with rising or high humidities and decreases in length with falling or low humidities. These changes in length make it possible to make humidity markings on a record chart.

The relative humidity hair element is secured at the lower end to a pivoted end clamp. This is similar to that of the temperature element and permits adjustment of hair tension when setting to current humidity. The upper end of the element is attached to a small lever arm that operates the upper lever cam through a vertical link and lever arm. The marking pen, attached to this lever arm, is of the pressure gravity type.

The humidity and temperatures are read on a hygrothermograph chart by first finding the point at which the appropriate printed time curve intersects the humidity and temperature traces. This point is evaluated in terms of humidity and temperature by referring it to the closest of the horizontal printed lines of numbers on the graph. The hygrothermograph should be mounted on a horizontal platform, centrally located in the dry locker, with the base at least 3 feet from the deck. (See fig. 2-5.)

The graph or chart should be filed for future reference and comparison. In this way the effectiveness of an air-conditioning system can be evaluated. In the absence of an air-conditioning unit, the records compiled by the hygrothermograph can justify the request for air conditioning. The chart is very simple to install on a rotating drum of the instrument, which is spring operated to run with the accuracy of a clock. The chart is marked from Monday through Sunday. Obviously, the time to change the graph is the first thing Monday morning. A key is provided to wind the eight-day mechanism.

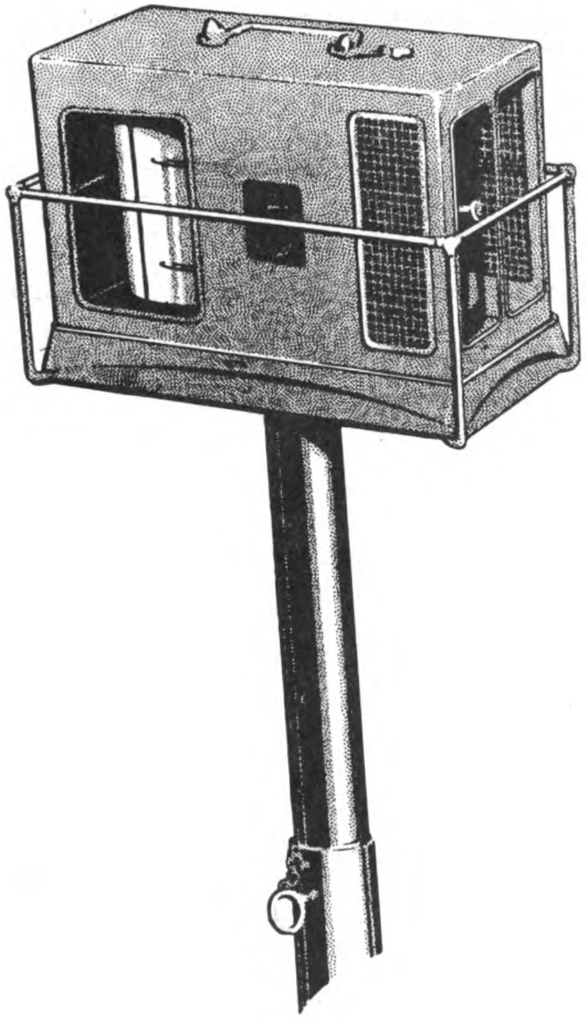

Figure 2-5.—Hygrothermograph.

Fabric Section

A well-established parachute loft has a range of sewing machines that will adequately handle light, medium, and heavy duty work. Light duty work, in most instances, is in the minority; while the medium work (heavily woven cloth and lightweight canvas) requires the greatest amount of time, and the equipment occupies the most space. Heavy canvas and webbings are in the middle of the workload program and the space and location allotted to these machines should be governed accordingly. Sewing machines are capable of performing perfectly, provided they are given the proper care and are used on the materials they were designed to handle. Maintenance and repair of sewing machines is covered in chapter 4.

CUTTING TABLE.—A cutting table should be from 30 to 33 inches high, so that the Parachute Rigger may comfortably perform any cutting operation. The table should be at least 54 inches wide to handle the most popular widths of materials. The length depends on the available area and the workload.

LOCKERS.—Lockers should be located in the vicinity of the fabric section. Small items like measuring instruments, and cutting, stapling, and setting tools should be safely stowed in lockers. Needles and spare sewing machine parts should be stowed in a manner to keep dust from them. The number and location of lockers required to satisfactorily stow all necessary items can only be determined by the available space in the parachute loft.

FABRIC RACKS.—A fabric rack of a simple and strong design, as shown in figure 2-6, is needed for the purpose of moving the material about the shop. This unit was constructed to withstand a load of 700 pounds. Not all fabric racks need to be portable. The major part of the work being performed, the location, and the facilities of the fabric section will determine the design of the rack.

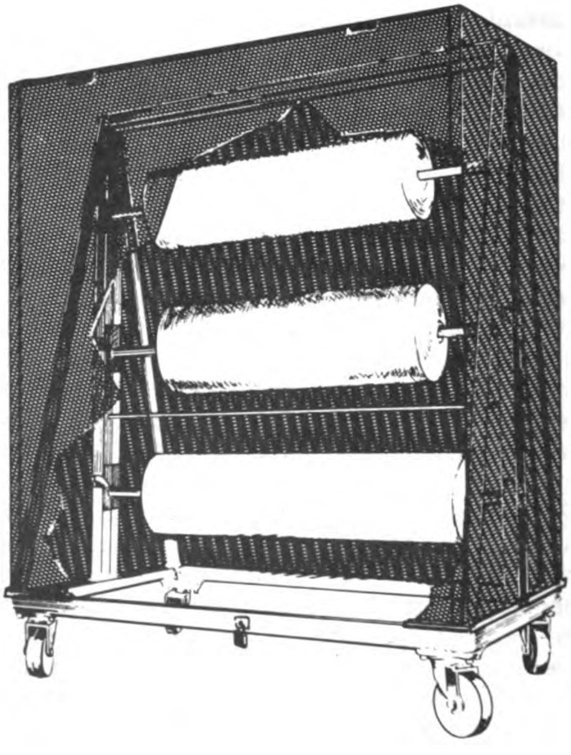

Figure 2-6.—Fabric rack.

STENCILING TABLE.—A table especially designed for stenciling purposes is a useful accessory. When a special table is not available, and when the lack of space restricts the number of tables, a combination worktable can be constructed. The construction should be heavy and sturdy with top dimensions large enough to accommodate a packed parachute when laid out flat. A drawer for stowing stencils and stenciling ink and brushes should be included.

A table of this type could be used for setting grommets, snaps, and fasteners. A small vise installed on the table has unlimited uses, and there should also be enough space for placing the wax pot, which is necessary for some fabric work. Another item installed on this table is a searing wire which can be locally constructed. It should be rigged across a gap and insulated. This searing wire will sever and sear the edges and ends of nylon in one operation.

BLUEPRINTS.—Blueprints are not just scraps of paper. They are valuable permanent records and can be used again and again if you take care of them. Here are a few simple rules for getting the best results from them.

1. Keep them out of strong sunlight—they might fade.
2. Do not allow them to get wet or grease-smudged.
3. Do not make pencil or crayon notations on a print without proper authority. If you should get instructions to mark a blueprint, use a yellow pencil. Ordinary (black lead) pencil marks are hard to see on a colored background.
4. Never measure distance on a blueprint. If you cannot find a dimension on one view, look at another view. If you still cannot find it, ask someone who knows. Why not measure? Because the original mechanical drawings might not have been drawn exactly to scale, or the print may have shrunk or stretched.
5. Keep blueprints stowed in their proper place so that they can be readily located the next time you want to refer to them.

Specifications, Characteristics, and Uses of Fabric Materials

The tensile strengths of the materials used in the manufacture and repair of parachutes are listed in Military Specifications. Specifications detail the physical quality of any product, depending on its use and purpose. All materials used in making a parachute are manufactured to the highest standards of workmanship. No one has the authority to change any item in the manufacturing process without the permission of the specifying agency. The parachute is therefore manufactured in strict accordance with many specifications and drawings, and must be so maintained throughout its service life if it is to perform properly.

A Parachute Rigger should not tolerate the use of substitutes or substandard materials in the fabrication or repair of survival equipment. A knowledge of specifications and tensile strengths better equips the Parachute Rigger to design local projects which must meet specified tensile strengths requirements.

NYLON THREAD.—Nylon thread and cord are classified as types I and II, and are used in the manufacture of parachutes. Type I is a machine twist thread. Type II is a twisted bonded multicord thread. These threads and cords are in class 1, which is a low-stretch thread with a maximum elongation of 22 percent. Specifications for nylon thread may be found in MIL-T-7807B.

The minimum breaking strength in pounds for nylon threads and cords follows:

Thread size:		Cord size:	
A	2.75	3	24.00
B	5.50	6	50.00
E	8.50		
FF	16.00		

NYLON CORD.—Nylon cord used for suspension lines for pilot chutes and parachutes can be found in Specification MIL-C-5040B(ASG). Type I cord, 100 pounds breaking strength, is used for the lines of Martin-Baker pilot chutes. Type III, 550 pounds breaking strength, is used for constructing the suspension lines of the main parachute.

NYLON REINFORCING TAPE.—Reinforcing tape comes in many widths and styles. This tape is used on parachute container reinforcements, edgings, making hesitator loops and retainers, and general strengthening of all stress areas. Specifications for tapes used can be found in MIL-T-5038A.

Many of the tapes can be identified by observing the pattern of their weaves. Type II tape is a plain weave. Type IV tape is composed of two ground warps. Type VI tape is a herringbone style which differs only slightly from type IV.

Type II tape is 3/4 inch wide and has a minimum breaking strength of 400 pounds. Type IV tape comes in both 1-inch and 1 1/2-inch widths. The 1-inch width has a minimum breaking strength of 1,000 pounds, while the breaking strength of the 1 1/2-inch width is 1,500 pounds. Type VI tape is 3/4 inch wide and has a breaking strength of 425 pounds.

NYLON WEBBING.—Soft textile nylon webbing (Specification W-54) is used for constructing parachute harnesses. This webbing, 6,000 pounds breaking strength, is olive drab in color. The width is 1 23/32 ± 1/16 inches.

NYLON TUBULAR WEBBING.—Nylon tubular webbing is neutral in color and is used in reinforcement of the parachute canopy.

These webbings are covered in the following specifications:

MIL-W-4088B (USAF).
MIL-W-6134A.
MIL-W-5625D.

The 1-inch nylon tubular webbing has a breaking strength of 3,000 pounds and is used for the vent reinforcement. The nylon warp and cotton filler webbing is also 1 inch and has a breaking strength of 525 pounds. It is used to reinforce the skirt hem. The 1/2-inch tubular webbing has a breaking strength of 1,000 pounds and is used for the Martin-Baker pilot chute connector cord.

NYLON PARACHUTE CLOTH.—Nylon parachute cloth is found in Specification MIL-C-7020B(ASG). This cloth is neutral in color unless otherwise specified, and is used in constructing the gores and panels of the parachute canopy.

The specification states that the maximum weight cannot be more than 1.1 ounces per square yard. The breaking strength in minimum pounds per inch of width is 40 pounds. The minimum tear resistance is 3.5 pounds for both the warp and filling thread. The air permeability in cubic feet per minute per square foot of cloth is 80 to 120.

HARNESS HARDWARE.—The harness hardware (Specification MIL-H-7195) comes in many styles and varieties. The uses of the hardware in the construction of the parachute harness can be found in this specification. Hardware that is salvaged from old or surveyed harnesses can be used for many different local constructions. The choice of hardware to be used depends on the use of the equipment and the test load to which the adapters, buckles, snaps, etc., will be subjected.

Laundry

Since the Navy is associated with salt water, it is only logical to expect an occasional salt water soaked parachute. Every parachute loft should be equipped with an inexpensive washtub, located in a separate section remote from the dry locker, for the purpose of rinsing parachutes.

Hoisting lines rigged directly over the tubs offer an excellent means of pulling the parachutes out of the rinse water for drying. A fan located on the deck will move a greater quantity of air through the wet fabric than would otherwise be possible. Under no circumstances ever allow a wet parachute to be hung in the dry locker.

Storeroom

A separate storeroom is usually provided in parachute lofts at large naval air stations. Heavy workloads will nessitate keeping a stock of various fabrics and materials on hand for ready use. It is not absolutely necessary to have a separate storeroom, as there is usually ample storage bins in the dry locker.

Parachutes that have not been put into commission should be left unopened in the container in which they are packed by the manufacturer. The method of pack is suitable for all climates. Dampness is no longer a problem since there are so many efficient dehumidifiers available.

Do not overstock on items that cannot be used in the normal time for routine requisitioning of materials from the supply department. Overstocking is a wasteful process, and storage space is inadequate in many spaces assigned to the parachute loft.

Flammable Gear Lockers

All flammable materials are to be stored in special lockers or shacks outside of the parachute loft. When in doubt about the flammable characteristics of liquids, cements, or pastes, check with the station fire department. Regardless of the location of the flammables, the structure housing them should be ventilated. Some flammables are rendered useless if frozen and must be stored at temperatures well above freezing. Before any of these items can be stored indoors in metal lockers away from heat sources, special permission must be secured from the squadron or station first lieutenant. These officers are guided by local station regulations and the fire chief, who is responsible to the commanding officer for the fire security of all buildings and structures located on the base.

Avoid spontaneous combustion situations. Oil and paint-soaked rags should be placed in special containers provided for the purpose. When in doubt about the combustion potential of any liquid-soaked rag, hang it where the air can circulate freely around it. Never store dirty rags in a heap.

Safety Precautions

Since safety is a Parachute Rigger's job, every man assigned to the loft should be thoroughly checked out in safe working conditions. Each chapter in this training course gives standard safety precautions for the particular equipment with which it deals.

Commonsense and supervision will eliminate many everyday accidents in the parachute loft. Sharp, clean tools, and the right tool for the right job should be used at all times. Substitutions can be dangerous.

Heavy voltage required for the sewing machines, air conditioner, wax pot, nylon cutters, etc., when all used at once, may overload the electrical circuits. When in doubt, always have a qualified electrician install and periodically check the electrical installations.

LOFT ADMINISTRATION

As a senior Parachute Rigger in charge of the parachute loft, you will have a number of administrative duties and responsibilities. It will be your job to procure needed loft equipment and spare parts as well as flight clothing and other materials. You will plan, schedule, and direct work assignments; maintain an adequate file of aeronautical publications; interpret and comply with bulletins and other directives; maintain records and reports; carry on an instructional program for loft personnel; and instruct pilots and aircrewmen in the use of protective clothing and survival equipment.

Records and Reports

Records are important for proper accountability of materials and equipment as well as for logging inspections, modifications, and changes. Included among the records that must be kept are Parachute Record Cards, Parachute History Cards, liferaft inspections, lifevest inspections, and the static load tests of aircraft safety belts and shoulder harnesses. Records should also be kept of oxygen regulator bench checks, regulator modification changes, and oxygen cylinder contamination tests. These records are subject to inspection at any time by higher authorities and should be kept neat, accurate, and up to date at all times.

Since the actual keeping of the above records is usually performed by a lower rated man, proper procedures for maintaining them have been included in *Parachute Rigger 3 & 2*, NavPers 10358-A, and are therefore not repeated here.

In addition to the above records, there are a number of reports that must be submitted by the Parachute Rigger from time to time. Included among these are material failure reports, maintenance usage reports, and survey requests. Procedures for submitting these reports are described on the following pages.

MATERIAL FAILURE REPORTS (FUR'S).—All naval activities operating and maintaining aeronautical equipment are required to prepare and submit reports concerning failures or unsatisfactory conditions relating to all aeronautical materials used in connection with the operation, maintenance, overhaul, and manufacture of aircraft and associated equipment. Data provided by these reports are required for use in the Naval Aeronautical Material Program.

The purposes of these reports are (1) to supply accurate and current information concerning the kinds and numbers of specific failures. (2) to provide facts useful as guides in procurement of equipments and supplies, and (3) to give data pertaining to the reliability of existing equipment and indicating any need for modification or redesign.

The system of reporting employs the Failure, Unsatisfactory, or Removal Report, NavAer 3069, commonly referred to as the FUR. These forms are supplied as eight-page sets with carbon interleaves, and all eight sheets are used for the majority of reporting situations. The first sheet of the set is available in pads of 100 for use as worksheets and also for reporting unsatisfactory conditions where a turn-in of material is not required. The FUR forms are supplied by regular publication supply sources and may be ordered on Publications and Forms Order Blank, Nav Aer 140.

A FUR form is made out whenever a part or item of equipment has exhibited a malfunction, has failed, or is removed from an assembly or system. High usage items such as bolts, nuts, and the like do not require a FUR report except in cases where an item requires abnormal replacements or fails far short of expected life.

A separate FUR is required for each item replaced, except when a quantity of like items with the same stock number identification are replaced. In the latter case a single FUR may be used.

The top sheet of the eight-page set is the basic reporting document and is sent to the FUR Center. Pertinent data is entered on the other sheets by carbon registration.

Operating activities are responsible for insuring that the reports submitted contain an accurate description of the failed item, including the correct stock number, part number, contract number, and manufacturer. Efforts should be made to determine precise causes of component failures or malfunctions.

The FUR is commenced by the individual performing the maintenance operation or discovering the unsatisfactory condition. In accordance with the convenience of each organization, the FUR set may be completed by persons possessing records helpful in providing operating time, parts identification, and other necessary da If the failure is investigated, the person or pe sons making the investigation will complete t FUR. Signature should be by the senior pers involved in the preparation or review of t FUR. Petty officer signatures are particular encouraged for FUR's not requiring investigation.

Complete instructions, including complete samples of the different types of FUR's, a found in *BuAer Instruction*, 13070.1 serie This instruction should be read and used by a personnel concerned with submitting FUR'

MAINTENANCE USAGE DATA.—The Av ation Supply Office (ASO) has established a pro cedure to be used by specifically designate maintenance activities in reporting materi usage. The purpose of reporting this data to provide a basis for computing amounts maintenance material that must be purchase and made available for maintenance. It als provides data that is used in determinin quantities of items allowed by the allowanc lists for each organization.

The maintenance usage data report list the quantity of parts, sub-assemblies, or assemblies actually removed during a reportin period because of unsatisfactory operation, an for which a replacement was required. Whe subassemblies or assemblies are repaired locally, usage reports should not indicate usage the subassembly or assembly, but should indica only the parts utilized in effecting the repai Reports of assemblies or subassemblies us should cover only those sent to O & R.

The maintenance officer is responsible f collecting and submitting the maintenance usa report to ASO. Each shop, including the pa chute loft, is required to keep a daily us record and turn it in to the maintenance off monthly. The data are then compiled and ente on the form supplied by ASO. This report to be submitted to ASO by the 5th day of following month.

SURVEY REQUESTS.—A survey is the p cedure required when an accountable item m be expended from the records due to lo damage, deterioration, or normal wear. T survey request provides a record showing cause, condition, responsibility, recommen tion for disposition, and authority to expe the material from the records. Since par chute lofts stock and maintain a great deal countable material, it is necessary for Paraute Riggers to have a knowledge of survey ocedures.

The custodian of the item to be surveyed preres a written statement of the circumstances known or suspected. The survival officer then iginates a rough Survey Request, Report, and penditure (SandA Form 154). It is processed rough the operations officer and then to the pply officer for preparation of the smooth sury which is then signed by the survival officer, erations officer, and commanding officer.

There are two types of surveys—formal and formal. A formal survey is required for those asses of material so designated by the bureau office concerned, or the commanding officer. he survey is conducted by a commissioned ficer or a board of three officers, as appointed the commanding officer. Informal surveys e conducted by the department head when rected by the commanding officer.

When a person in the naval service is found be culpably responsible for actions necesitating a survey, he will be contacted by the urveying officer for a statement. The sureying officer must then recommend discilinary action as the circumstances require. note of such action will be made on the urvey report and the Chief of the Bureau of aval Personnel notified of the disciplinary ction taken.

Procurement of Materials and Equipment

Procurement of materials and equipment is ne of the most important responsibilities of senior Parachute Riggers. The parachute loft must not only be equipped to perform the reuired workload, but also must carry many tems for reissue to flight personnel. The est guides are BuWeps Allowance Lists and Tables of Basic Allowances.

ALLOWANCE LISTS.—Allowance Lists and Tables of Basic Allowances are identified by sections. They contain listings of equipment and materials (both expendable and accountable) authorized for use by the various types of activities. Certain sections such as A, H, and U are issued as individual publications. Others such as B, BR, and R are issued as a series of publications, each of which is applicable to a specific model of equipment, model of aircraft, or type of activity. Sections of primary interest to the Parachute Rigger are sections A, B, H, and K.

Section A is a listing of standard aeronautical and Navy stock account material, and includes such items as webbing, fabric materials, needles, and oxygen equipment. Section A does not indicate what the parachute loft is authorized as an outfitting allowance, but is handy as a reference for stock numbers and nomenclature.

Section B is issued for each model of naval aircraft. This list contains valuable information for ordering parts for a specific aircraft, such as oxygen regulators.

Section H contains listings of flight operational materials which squadrons and other activities rate as a commissioning allowance. Such items as parachutes, lifejackets, dye markers, shark chasers, and other miscellaneous items are contained in this section.

Section K lists the general types of aeronautical publications and forms which are provided as a commissioning allowance for all types of activities.

REQUISITIONING MATERIALS.—Defense Department (DD) Forms 1150 and 1150A, Request for Issue or Turn-in, are used by aviation activities both ashore and afloat to requisition or turn in materials. DD Form 1150 (white) is used to requisition materials. DD Form 1150A (yellow) is used to turn in materials. NOTE: Ships and stations equipped for mechanized supply procedures use accounting machine type requisitions which will not be discussed here.

Requisitions for material are divided into two general categories: not-in-excess material and in-excess material.

Not-in-Excess Requisition.—Requisitions for the following materials are considered to be not-in-excess:

1. Equipage on an activity's allowance not in greater quantity than necessary to bring the amount on hand and on order up to full allowance.
2. Consumable supplies listed in *Navy Stock Lists* or applicable lists.
3. Repair parts listed with quantities in allowance lists for which a requirement can be justified above the quantity fixed by the allowance.
4. Material other than consumable supplies required for immediate expenditure for repairs

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Records and Reports

Records are important for proper accountability of materials and equipment as well as for logging inspections, modifications, and changes. Included among the records that must be kept are Parachute Record Cards, Parachute History Cards, liferaft inspections, lifevest inspections, and the static load tests of aircraft safety belts and shoulder harnesses. Records should also be kept of oxygen regulator bench checks, regulator modification changes, and oxygen cylinder contamination tests. These records are subject to inspection at any time by higher authorities and should be kept neat, accurate, and up to date at all times.

Since the actual keeping of the above records is usually performed by a lower rated man, proper procedures for maintaining them have been included in *Parachute Rigger 3 & 2*, NavPers 10358-A, and are therefore not repeated here.

In addition to the above records, there are a number of reports that must be submitted by the Parachute Rigger from time to time. Included among these are material failure reports, maintenance usage reports, and survey requests. Procedures for submitting these reports are described on the following pages.

MATERIAL FAILURE REPORTS (FUR'S).—All naval activities operating and maintaining aeronautical equipment are required to prepare and submit reports concerning failures or unsatisfactory conditions relating to all aeronautical materials used in connection with the operation, maintenance, overhaul, and manufacture of aircraft and associated equipment. Data provided by these reports are required for use in the Naval Aeronautical Material Program.

The purposes of these reports are (1) to supply accurate and current information concerning the kinds and numbers of specific failures, (2) to provide facts useful as guides in procurement of equipments and supplies, and (3) to give data pertaining to the reliability of existing equipment and indicating any need for modification or redesign.

The system of reporting employs the Failure, Unsatisfactory, or Removal Report, Form NavAer 3069, commonly referred to as the FUR. These forms are supplied as eight-page sets with carbon interleaves, and all eight sheets are used for the majority of reporting situations. The first sheet of the set is available in pads of 100 for use as worksheets and also for reporting unsatisfactory conditions where a turn-in of material is not required.

The FUR forms are supplied by regular publication supply sources and may be ordered on Publications and Forms Order Blank, Nav Aer 140.

A FUR form is made out whenever a part or item of equipment has exhibited a malfunction, has failed, or is removed from an assembly or system. High usage items such as bolts, nuts, and the like do not require a FUR report except in cases where an item requires abnormal replacements or fails far short of expected life.

A separate FUR is required for each item replaced, except when a quantity of like items with the same stock number identification are replaced. In the latter case a single FUR may be used.

The top sheet of the eight-page set is the basic reporting document and is sent to the FUR Center. Pertinent data is entered on the other sheets by carbon registration.

Operating activities are responsible for insuring that the reports submitted contain an accurate description of the failed item, including the correct stock number, part number, contract number, and manufacturer. Efforts should be made to determine precise causes of component failures or malfunctions.

The FUR is commenced by the individual performing the maintenance operation or discovering the unsatisfactory condition. In accordance with the convenience of each organization, the FUR set may be completed by persons possessing records helpful in providing operating time, parts identification, and other necessary data. If the failure is investigated, the person or persons making the investigation will complete the FUR. Signature should be by the senior person involved in the preparation or review of the FUR. Petty officer signatures are particularly encouraged for FUR's not requiring investigation.

Complete instructions, including completed samples of the different types of FUR's, are found in *BuAer Instruction*, 13070.1 series. This instruction should be read and used by all personnel concerned with submitting FUR's.

MAINTENANCE USAGE DATA.—The Aviation Supply Office (ASO) has established a procedure to be used by specifically designated maintenance activities in reporting material usage. The purpose of reporting this data is to provide a basis for computing amounts of maintenance material that must be purchased and made available for maintenance. It also provides data that is used in determining quantities of items allowed by the allowance lists for each organization.

The maintenance usage data report lists the quantity of parts, sub-assemblies, or assemblies actually removed during a reporting period because of unsatisfactory operation, and for which a replacement was required. When subassemblies or assemblies are repaired locally, usage reports should not indicate usage of the subassembly or assembly, but should indicate only the parts utilized in effecting the repair. Reports of assemblies or subassemblies used should cover only those sent to O & R.

The maintenance officer is responsible for collecting and submitting the maintenance usage report to ASO. Each shop, including the parachute loft, is required to keep a daily usage record and turn it in to the maintenance office monthly. The data are then compiled and entered on the form supplied by ASO. This report is to be submitted to ASO by the 5th day of the following month.

SURVEY REQUESTS.—A survey is the procedure required when an accountable item must be expended from the records due to loss, damage, deterioration, or normal wear. The survey request provides a record showing the cause, condition, responsibility, recommendation for disposition, and authority to expend the material from the records. Since parachute lofts stock and maintain a great deal of accountable material, it is necessary for Parachute Riggers to have a knowledge of survey procedures.

The custodian of the item to be surveyed prepares a written statement of the circumstances as known or suspected. The survival officer then originates a rough Survey Request, Report, and Expenditure (SandA Form 154). It is processed through the operations officer and then to the supply officer for preparation of the smooth survey which is then signed by the survival officer, operations officer, and commanding officer.

There are two types of surveys—formal and informal. A formal survey is required for those classes of material so designated by the bureau or office concerned, or the commanding officer. The survey is conducted by a commissioned officer or a board of three officers, as appointed by the commanding officer. Informal surveys are conducted by the department head when directed by the commanding officer.

When a person in the naval service is found to be culpably responsible for actions necessitating a survey, he will be contacted by the surveying officer for a statement. The surveying officer must then recommend disciplinary action as the circumstances require. A note of such action will be made on the survey report and the Chief of the Bureau of Naval Personnel notified of the disciplinary action taken.

Procurement of Materials and Equipment

Procurement of materials and equipment is one of the most important responsibilities of senior Parachute Riggers. The parachute loft must not only be equipped to perform the required workload, but also must carry many items for reissue to flight personnel. The best guides are BuWeps Allowance Lists and Tables of Basic Allowances.

ALLOWANCE LISTS.—Allowance Lists and Tables of Basic Allowances are identified by sections. They contain listings of equipment and materials (both expendable and accountable) authorized for use by the various types of activities. Certain sections such as A, H, and U are issued as individual publications. Others such as B, BR, and R are issued as a series of publications, each of which is applicable to a specific model of equipment, model of aircraft, or type of activity. Sections of primary interest to the Parachute Rigger are sections A, B, H, and K.

Section A is a listing of standard aeronautical and Navy stock account material, and includes such items as webbing, fabric materials, needles, and oxygen equipment. Section A does not indicate what the parachute loft is authorized as an outfitting allowance, but is handy as a reference for stock numbers and nomenclature.

Section B is issued for each model of naval aircraft. This list contains valuable information for ordering parts for a specific aircraft, such as oxygen regulators.

Section H contains listings of flight operational materials which squadrons and other activities rate as a commissioning allowance. Such items as parachutes, lifejackets, dye markers, shark chasers, and other miscellaneous items are contained in this section.

Section K lists the general types of aeronautical publications and forms which are provided as a commissioning allowance for all types of activities.

REQUISITIONING MATERIALS.—Defense Department (DD) Forms 1150 and 1150A, Request for Issue or Turn-in, are used by aviation activities both ashore and afloat to requisition or turn in materials. DD Form 1150 (white) is used to requisition materials. DD Form 1150A (yellow) is used to turn in materials. NOTE: Ships and stations equipped for mechanized supply procedures use accounting machine type requisitions which will not be discussed here.

Requisitions for material are divided into two general categories: not-in-excess material and in-excess material.

Not-in-Excess Requisition.—Requisitions for the following materials are considered to be not-in-excess:

1. Equipage on an activity's allowance not in greater quantity than necessary to bring the amount on hand and on order up to full allowance.
2. Consumable supplies listed in *Navy Stock Lists* or applicable lists.
3. Repair parts listed with quantities in allowance lists for which a requirement can be justified above the quantity fixed by the allowance.
4. Material other than consumable supplies required for immediate expenditure for repairs

or alterations, or to replace material so expended.

5. Services which cannot be accomplished by ship's force.

6. Consumable supplies (special materials and services) requisitioned in accordance with *BuSandA Manual*.

7. Nonstandard consumable supplies requisitioned in accordance with *BuSandA Manual* (special aeronautical material).

In-Excess Requisitions.—Requisitions for the following material are considered to be in-excess:

1. Equipage not on an activity's allowance.
2. Equipage on the allowance list, but in greater quantitities than allowed.
3. Consumable supplies not listed in the *Navy Stock Lists*, applicable allowance list, or *BuSandA Manual*.
4. Repair parts not listed with quantities in allowances for which a requirement can be justified.

DD Form 1150.—DD Form 1150 is used as a station requisition in the following manner:

1. To request issues of material or services for final use, provided that there are funds available to cover the issues.
2. To request replenishment of ready issue store material.
3. To request issue of material from a ready issue store.

DD Form 1150 may also be used to communicate purchase requirements between requiring activities and Navy purchasing offices or other purchasing activities of the Navy.

Only one Federal supply classification group may be contained on each station requisition. Station requisitions are signed by the head of the requesting department or activity, or by his authorized representative. It is the local policy at some air stations to permit only one item on a station requisition.

MATERIAL REQUIREMENTS PRIORITY SYSTEM.—The Material Requirements Priority System was established to achieve the proper utilization of material resources and insure that requirements are processed in accordance with military importance and urgency of need.

Under the current system, mission categories are assigned to ships, units, and activities according to relative military importance of the mission assigned to them.

Requests for material or equipment are assigned a numerical priority number ranging (with diminishing importance) from number 1 through 37. These priority designators are designed to provide a means for supply and transportation activities to process requests and shipments in accordance with the urgency of need.

Since the Priority System is currently undergoing a number of changes, details of its operation are not included in this training course.

LOCAL PROCUREMENT OR PURCHASE.—In the procurement of materials, items not stocked by the Navy Supply Department are sometimes needed. Procurement of such items is known as local procurement or local purchase. An example of materials which the Parachute Rigger must procure by local purchase is spare parts for sewing machines, needles excepted. From time to time, it may be necessary to procure other needed items by this method.

When an activity desires to make a local purchase of material, a request must be submitted to the supply officer, giving the following information:

Priority designator.
Date material required (DMR).
Justification.
Request number.
Quantity required for immediate use.
Name and address of local supplier.

Flight Clothing Pools

Flight clothing pools are maintained for the purpose of providing flight clothing to individuals not eligible to receive such items on a personal-issue basis.

The supply officer of an aviation supply activity or the supply or material officer of the fleet aviation unit arranges for the establishment of flight clothing and parachute pools sufficient to meet necessary operational requirements. The commanding officer designates an officer, other than an officer connected with the supply department, as the responsible officer of the pool.

Issues of flight clothing, flight operational equipment, and parachutes to the pool by the supply officer are made on Request for Issue or Turn-in (DD Form 1150). Items of flight clothing other than Navy stock account material so transferred are expended as a cost charge to the current appropriation expenditure, account 33020, and appropriate allotment of the aviation squadron or station concerned.

Initial outfitting of the flight clothing and parachute pool is considered as nonreplenishable issue; subsequent issues to replace torn, lost, or overage items are considered as replenishable issues. Flight clothing and parachute pools operated by squadrons carry only those items and quantities authorized by BuWeps Allowance Lists. Equipage stock card and custody record are not maintained by the issuing supply officer for items issued to fill the authorized Section H Allowance Lists. The squadron commanding officer or his designated representative is responsible for the accountability of equipage items carried in the flight clothing and parachute pools.

Normally, used articles of flight clothing and equipment are issued to these pools; new items are issued only when used material is not available. For hygienic reasons, shoes (field, N-1) and summer caps are not included in the pool.

When an individual not otherwise eligible requires flight clothing and equipment for flight purposes, such items as are needed are furnished him from the pool, and a custody receipt is signed by him for the items furnished. On completion of the orders to duty involving flying or the flights for which the clothing was needed, the individual returns the items to the pool, at which time the custody receipt is surrendered.

If an individual being transferred from one station to another requires flight clothing en route, the necessary clothing may be issued from the flight clothing pool and covered by a custody receipt signed by the individual. Such clothing should be invoiced by the issuing activity to the activity to which the individual is being transferred. Original signed custody receipts should be attached to the original invoice.

Pilots and aircrewmen are issued flight clothing from the pool. A custody receipt is signed by the individual for the items furnished. Upon completion of the orders to duty involving flying, or when he is transferred to another station, the individual returns the items to the pool at which time the custody receipt is surrendered.

Articles of flight clothing should be returned to the pool when:

1. They have become unserviceable because of damage or wear.
2. They are in need of cleaning or repair.
3. A different size is required for proper fitting.

PREPARATION FOR DEPLOYMENT.—In preparing for deployment to an advanced base or forward area, the senior Parachute Rigger in charge of the loft is responsible for estimating material and equipment requirements. Obviously, the geographical location of the base or area will be a determining factor in any such preparation. For example, it would be a waste of time and material to take heavy woolens to the tropics or lightweight protective clothing to the Arctic.

The best policy is to make a thorough check of all applicable allowance lists and make certain all authorized materials are on hand. In addition, make certain all parachutes, lifejackets, rafts, etc. are in the best of condition and that the final "striking date" will not occur while deployed. Always keep in mind that supply at most advanced bases does not stock many of the items which might be required for immediate use. Do not wait until the last minute to order supplies and equipment needed. Advance planning is especially important for procuring spare sewing machine parts and other items that have to be obtained through local purchase.

Special equipment and protective clothing which will be required by the activity and is not authorized in the applicable allowance lists should be determined and authorized by the parachute officer through supply.

Aeronautic Publications

Aeronautic publications are issued by authority of the Chief of the Bureau of Naval Weapons and are the sources of information for guiding naval personnel in the operation and maintenance of all aeronautic equipment within the Naval Establishment. Each parachute loft is required to maintain an up-to-date file of publications relating to the equipment under its jurisdiction.

Aeronautic publications may be grouped into two major classes or groups—those issued in the form of MANUALS and those issued in the form of LETTER MATERIAL.

When a new item of equipment is accepted by the Navy, manuals necessary to insure its proper operation and upkeep are prepared and issued to all activities using and/or maintaining the equipment. Supplemental information and other directive type publications that must be issued from time to time are issued in the form of letter material.

As an example, when a new oxygen regulator is accepted by the Navy, a manual covering maintenance of the regulator is issued. Later, if it becomes necessary to issue information concerning repair or use of the regulator, or a modification to the regulator is necessary, letter type publications are issued.

All aeronautic publications, both manuals and letter material, are assigned a title and code number and listed in the *Navy Stock List of Forms and Publications*, NavSandA Publication 2002, when they become available for issue. Manual type publications are listed in Part C of the BuWeps Section of the Stock List. Letter type publications are listed in Part D.

In order to use aeronautic publications intelligently, a general knowledge of the publications numbering system is necessary.

NUMBERING SYSTEM FOR MANUALS.—Code numbers assigned to manuals consist of a prefix and a series of three parts. The prefix may consist of NavAer, NavWeps, AN, TO, or CO.

NavAer, usually shortened to NA, indicates that the publication was originated by the Bureau of Naval Weapons.

NavWeps is replacing NavAer as new or reissued publications are reprinted. NavWeps is generally shortened to NW.

The prefix AN was previously assigned for manuals used by the Navy and the Air Force when they were prepared to coordinated Military Specifications. This prefix, while no longer assigned for new material, will remain in effect for existing assignments or until superseded by a later assignment.

TO is the prefix assigned to an Air Force originated manual.

CO was previously used to designate a manual with a confidential security classification. This prefix, while no longer assigned for new material, will remain in effect for existing assignments or until superseded by a later assignment.

The three parts which make up the remaining portions of the number indicate the following:

Part I is a two-digit number that indicates the general subject classification of the equipment covered by the publication. Table 2-3 lists the general subject categories and their numerical equivalents.

Part II of the publication number consists o numbers and/or numbers and letters and indicates the specific class, group, type, or model of the equipment. The subject breakdowns are listed at the beginning of each separate major division within the index.

Part III consists of a number or numbers which designate a specific manual. For aircraft and powerplants, this number designates a special type of manual. For other types of equipment this part is assigned in numerical sequence and has no reference to the type manual.

An example of a complete code number and its breakdown is the Overhaul Instruction Manual for the Automatic Positive Pressure Diluter Demand Oxygen Regulators, publications number AN 03-50A-48:

AN indicates that the manual was prepared to coordinated Military Specifications for joint use by the Navy and Air Force.

03 indicates that the publication is an accessories manual (table 2-3).

-50 indicates that the manual concerns oxygen equipment. The letter A has no specific significance in this case, but merely distinguishes this manual from another 03-50 series manual.

-48 is the numerical sequence number, indicating that this manual is the forty-eighth publication issued in the AN 03-50A series.

As shown in table 2-3, manuals of primary concern to the Parachute Rigger are issued in the 03 series (Accessories), 13 series (Parachutes and Personal Equipment), and the 17 and 18 series (Machinery Tools and Test Equipment). Others with which you might be concerned from time to time are issued in the 00 series (General) and 01 series (Aircraft). Included among the 00 series are Allowance Lists (00-35), Air Safety (00-75), and Aviation Training (00-80). All 01 series manuals concern specific models of aircraft.

NUMBERING SYSTEM FOR LETTER MATERIAL.—Letter material is numbered by three different methods. They are as follows:

1. Numbered in consecutive order on a calendar year basis. This method is used in

Table 2-3.—Subject categories and code numbers for aeronautic manuals.

General	00
Allowance lists	00-35Q
Training publications (aviation)	00-80
Aircraft	01
Power plants	02
Accessories	03
Hardware and rubber	04
Instruments	05
Fuels, lubricants, and gases	06
Dopes and paints	07
Ground servicing and automotive equipment	08-20, 14 & 19
Photography	10
Armament	11
Fuel and oil handling equipment	12
Parachute and personal equipment	13
Standard preservation and packaging instructions	15
Electronics	08 & 16
Machinery, tools, and test equipment	17 & 18
Descriptive data for aviation support equipment	20
Chemical equipment	24 & 39
Instructional equipment and training aids	09 & 28
Meteorology (aerology)	50
Ships installations	51

the numbering of Aviation Clothing and Survival Equipment Bulletins, Accessories Bulletins, Technical Orders, and Technical Notes. For example, *Aviation Clothing and Survival Equipment Bulletin* 18-61 is the eighteenth bulletin of this type issued in the year 1961, and *Accessories Bulletin* 31-62 is the thirty-first Accessories Bulletin issued in the year 1962.

2. Numbered in consecutive order according to subject matter. This method covers all Instructions and Notices. An example is BuAer Instruction 4750.1. The number 4750 indicates the general subject of the instruction, and the .1 indicates that it is the first instruction issued on that particular subject.

3. Numbered in consecutive order according to specific application. An example of this method is the numbering of Aircraft Service changes and Aircraft Bulletins. As a Parachute Rigger, you will seldom be concerned with directives in this category.

AVIATION CLOTHING AND SURVIVAL EQUIPMENT BULLETINS.—Without a doubt, the most important letter type publication, as far as the parachute loft is concerned is the Aviation Clothing and Survival Equipment Bulletin. These bulletins may contain instructions for modifying, repairing, testing, or using an item of clothing or survival equipment. A complete file of all those in effect must be maintained in the loft at all times.

Each bulletin contains complete instructions for performing the work and includes a list of materials required, source of the materials, disposition of removed materials (if applicable), and the estimated number of man-hours required. A blueprint, or working drawing, is also included and used as a guide in performing the work.

INTERPRETING AND COMPLYING WITH BULLETINS.—Interpreting of bulletins and supervising the job of complying with them requires careful reading and study on the part of the senior Parachute Rigger. In many instances a knowledge of blueprint reading is also necessary.

If you have not had previous training in blueprint reading, it is suggested that you obtain a copy of *Blueprint Reading and Sketching* (NavPers 10077-A) from your education office and study chapters 2 and 3.

If you have had some experience with blueprint reading, but need to refresh your memory on the meaning of certain lines and symbols, study figures 2-7 and 2-8. Figure 2-7 illustrates the various draftsman's lines; figure 2-8 is taken from *Aviation Clothing and Survival Equipment Bulletin* 42-57 and illustrates some of their uses. Further descriptions and uses of lines are given in the following paragraphs.

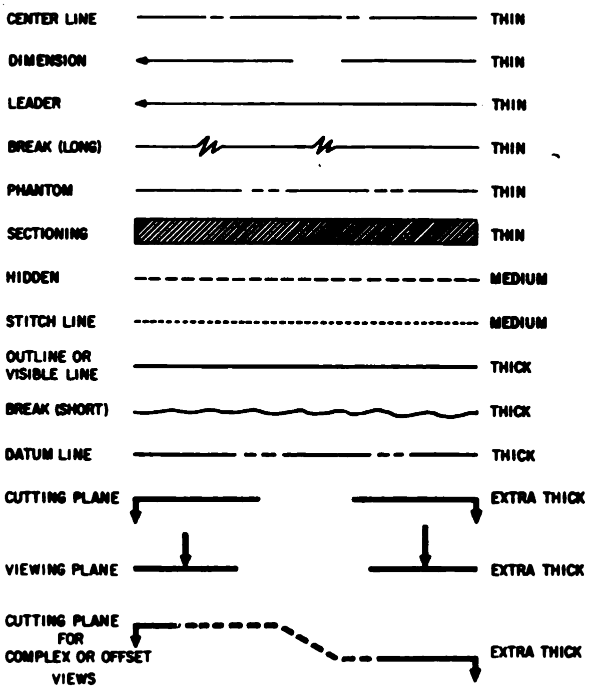


Figure 2-7.—Draftsman's lines used on blueprints.

Center lines are made up of alternate long and short dashes and are used to indicate the center of a circular object or part of an object.

Dimension lines are solid lines with arrowheads at either end and indicate dimensions or distance between two points on the drawing.

Leaders are solid lines with one arrowhead and are used to indicate a part or portion to which a note, number, or other reference applies.

Break lines are indicated by solid, freehand lines, and indicate that a portion of the object is not shown on the drawing.

Hidden lines consist of short dashes evenly spaced. Hidden lines are used to show the hidden features of a part.

Stitch lines indicate sewing or stitchin lines and consist of a series of dots or ver short dashes evenly spaced.

Cutting plane lines are used to indicate th plane in which a cross-sectional view of th object (shown elsewhere on the drawing) i taken. For example, in figure 2-8 the cuttin plane line indicates the plane in which Sectio A-A is taken.

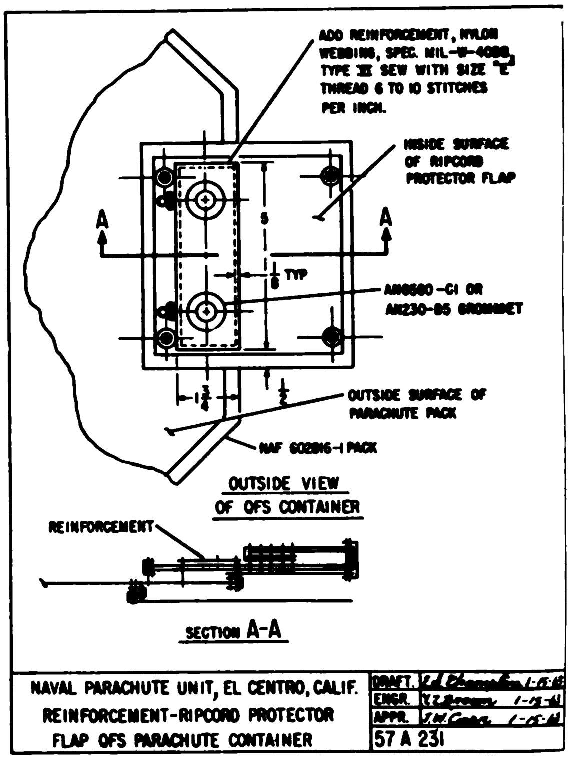

ADD REINFORCEMENT, NYLON WEBBING, SPEC. MIL-W-4088, TYPE III SEW WITH SIZE "E" THREAD 6 TO 10 STITCHES PER INCH.
INSIDE SURFACE OF RIPCORD PROTECTOR FLAP
A
A
5
1/8 TYP
AN6680-C1 OR AN230-B5 GROMMET
1 1/4
1/2
OUTSIDE SURFACE OF PARACHUTE PACK
NAF 602816-1 PACK
OUTSIDE VIEW OF OFS CONTAINER
REINFORCEMENT
SECTION A-A
NAVAL PARACHUTE UNIT, EL CENTRO, CALIF.
REINFORCEMENT-RIPCORD PROTECTOR
FLAP OFS PARACHUTE CONTAINER
DRAFT.
ENGR.
APPR.
57 A 231

Figure 2-8.—Example of blueprint accompanying a bulletin.

Section lines are used to indicate the exposed surfaces of an object in a sectional view. Sectional lines are often referred to as cross hatc lines.

PROCUREMENT OF PUBLICATIONS.—Requests for publications for which the publicatio code number and/or title is known should b addressed to the nearest publications supply point. The addresses of these supply points and the geographic areas served by each are given in the Navy Stock List of Forms and Publications. NavAer Form 140 should be used when ordering individual publications on a one-time requirement.

Changes to automatic distribution and inquiries concerning publications not listed in the Navy Stock List should be addressed to the Officer in Charge, Naval Air Technical Services Facility, Philadelphia, Pennsylvania. NavWeps Form 5605/2 should be used in all cases concerning changes to automatic distribution or initial outfitting.

Section K of the BuWeps Allowance List outlines the general types and classes of aeronautic publications and forms which are provided as a commissioning allowance (initial outfitting) for all types of activities.

Training of Loft Personnel

Training of loft personnel is a necessary function of the parachute loft and one of the most important responsibilities of senior Parachute Riggers. The extent to which you fulfill this responsibility will determine your ability as a supervisor and a petty officer. Much of what you know about your work came to you from the instruction of more experienced men.

As a Chief Parachute Rigger—and to some extent, even as a First Class—you will have regular and continuing responsibilities for the training of others. Even if you are fortunate to have a group of men who are highly skilled and well trained, you will find that training is necessary. For example, the training of strikers and lower rated men for advancement in rating examinations is a continuing, never-ending process. Also, some of your best men are likely to be transferred from the outfit, or men who are not so skillful or so well trained may come aboard and be assigned to you. These and similar problems require you to be a training specialist—a man who can set up as well as conduct an effective training program for parachute loft personnel.

Two types of training are briefly discussed in the following paragraphs. More detailed information on the subject of training is contained in *Military Requirements for Petty Officer 1 and C*, NavPers 10057.

ON-THE-JOB TRAINING.—Practically every task performed in the loft presents an opportunity for on-the-job training. The only equipment required is the job itself. The striker or trainee will learn something by seeing the job done, and he will gain experience by having a chance to participate in its accomplishment.

Whether or not loft personnel are able to take care of peak workloads will depend a great deal on how well you have utilized lax periods for training inexperienced personnel.

When you are working on a tight time schedule, you will generally want to assign each man to the job that you know he can do best. However, there are times when more can be gained in the long run by assigning a less qualified man to a job in order to give him a particular type of experience. For example, an expert rigger may know relatively little about sewing machine operation, and a good oxygen regulator man may know little about pressure suits. By giving these men a chance to do carefully supervised work in the area in which they are relatively unskilled, you will increase the skill of each man and thus increase the flexibility of your working group.

The first step in setting up an on-the-job training program is to make a careful study of the qualifications for advancement in rating. List all the PR3 qualifications that the striker must be able to perform and all the PR2 quals that the PR3 must be able to perform. Group the quals into logical units of work.

The Record of Practical Factors, NavPers 760(PR), should also be used as a guide. From this record you can determine which practical factors each man has already performed and which ones still remain to be checked off. You can then plan a program that will fill the specific needs of the men you are training.

LECTURE-DISCUSSION METHOD.—Although much of the instruction in the parachute loft should be in the form of on-the-job training, you will also be expected to lead classroom discussions and deliver lectures. Classroom instructing is a very complex skill; and in order to be an effective instructor, a great deal of preparation on your part is required.

An excellent reference on the techniques of teaching is the *Manual for Navy Instructors*, NavPers 16103-B. Listed below are some general suggestions that should be kept in mind.

1. Know the subject. The fundamental requirement in any teaching situation is a thorough knowledge of the subject to be presented.

2. Plan the lesson. The first thing to be determined is the specific objective of the lesson. Having decided upon the objective, select the exact points to be covered, then arrange the material in the most logical order.

3. Use training aids. Make full use of all available charts, diagrams, training films, slides, and the actual equipment when possible. Many of the applicable training films are listed in appendix II of this training course. For a complete listing of all Navy training films, refer to the *United States Navy Film Catalog and Supplements*, NavPers 10000-A, available in your information and education office.

4. Encourage student participation. Use every possible device to get student participation in the discussion. Ask questions of the group as a whole. When an answer is obtained from one trainee, ask others if they agree.

5. Summarize. Following any presentation, always review what has been covered, reinstructing in those phases in which the trainees have shown weakness, and showing how the lesson relates to new work.

6. Assign new material. Assignments should be made as carefully as the rest of the lesson was presented. The assignment should be clear, concise, and complete. It does not suffice to require merely the reading of certain pages from his Navy Training Course, or the working of certain problems; the trainee should be told why he is to read the pages or work the problems—what he is expected to learn from so doing.

Inspection of Work Areas and Equipment

As a first class or chief petty officer, you must take a tremendous amount of responsibility in the matter of safety. It is your responsibility to detect unsafe working conditions relative to working areas as well as equipment. It is also your responsibility to make sure that all loft personnel know and observe all safety precautions.

Safety precautions should always be taught as part of any training program. Strikers and lower rated men should be instructed to report any unsafe conditions or working habits that may be observed.

The chief in charge of the loft should personally inspect all areas at frequent intervals, insuring that the following conditions exist:

1. Hazardous areas and equipment are placarded with appropriate warning signs.
2. Passageways are clearly defined and kept free of hazardous obstructions.
3. Working areas are kept free of all unnecessary obstructions.
4. Materials are securely stacked so that there is no possibility of tipping.
5. Tools are handled and stored in a manner consistent with safe practices.
6. Racks are provided at locations where tools are frequently used.
7. Adequate lighting is provided for all machines, test stands, work benches, and passageways.
8. Clothing lockers are maintained in a clean and orderly condition and adequately ventilated.
9. Material is not stored on top or underneath lockers.
10. Flammable liquids are kept in designated spaces.
11. Personnel are instructed in safe operation of equipment and are complying with all safety regulations.

CHAPTER 3

SURVIVAL AND AIR-SEA RESCUE EQUIPMENT

PARACHUTE RIGGER'S RESPONSIBILITIES

Survival on land and sea, in all types of climates, calls for a wide variety of survival items to aid the pilot and aircrewman. As a First Class or Chief Parachute Rigger, you must be familiar with such equipment and insure that flight personnel have equipment available which is reliable for personal safety in flight as well as for escape and survival in case of emergency. In many operating activities it will be your responsibility to insure that flight personnel are instructed and trained in the use of this equipment and in the techniques of personal safety and survival.

The information contained in this chapter is for the purpose of aiding in preparing and carrying on a course of instruction for the flight personnel of your outfit and is taken from NavAer 00-80T-70, AF Manual 64-4, and various other official publications.

SURVIVAL AT SEA

The sea has ever been the implacable enemy of those who venture into or over its wastes, and modern rescue and survival equipment is designed to give victims of a disaster every possible chance to escape its clutches. The Navy has seen to it that the newest products of human ingenuity have been perfected and made available to the Parachute Rigger for the saving of lives.

Well-considered preparation, familiarization, and instruction in the use of survival equipment, made while there is time to prepare, will help flight personnel when an emergency exists. Every individual should be instructed to dress to cope with the physical conditions of the area over which he must fly and fight.

It is the responsibility of the Parachute Rigger to insure that proper gear is prepared for all aircraft. Survival equipment is useless to the crew if it is in the parachute loft or on the hanger deck. Aircraft must be checked before takeoff to see that the required items are aboard and in good condition.

Parachute Landings in Water

Under some conditions the most desirable place to make a parachute landing is in the water. The primary objective is to get free from the parachute harness at the proper time. Entering the water wearing the harness greatly hampers the movements of the individual; however, under no circumstances should the harness be left too soon.

Depth perception over water is wholly unreliable for accurately judging distance. In fact, there have been instances where jumpers have left the harness as much as 200 feet above the water. Severe injury may result from such a fall.

The objective is to leave the harness at the instant contact is made with the water; however, while still airborne, the pararaft should be removed from the kit container and slowly lowered until the full length of the retainer strap has been payed out.

After sliding out of the harness upon contact with the water, the body will submerge only to the shoulders or head. The life preserver should then be inflated.

In the event the wearer for some reason does not slide clear of the harness and it is necessary to deflate the canopy due to high winds on the water surface, this is accomplished by pulling in on any top suspension line or group of suspension lines. If wearing an integrated harness, which combines the restraint and harness systems, this is accomplished by opening the riser release fittings.

Before inflating the pararaft, all the snaps holding the pararaft in the case should be released. This will prevent tearing the raft body during inflation in case any of the flap securing snaps jam. If possible, the parachute should be saved and everything secured to the tiedowns on the pararaft for future use. An inventory of the equipment provided in the pararaft kit should then be taken. The individual should be thoroughly familiar with the use of the equipment before it is needed, because most of the time a person only has a few seconds to put this equipment into operation.

Aircraft Ditching

The pilot should conduct dry runs on practice ditchings with his crew to eliminate confusion and waste of time in case of an actual emergency ditching. Each crewman should know which exit he will use as well as a secondary exit in case he cannot reach his main exit. Commanding officers should time their crews to determine the length of time it takes to abandon or to ditch an aircraft. Each aircraft has an abandon aircraft and ditching bill which is posted at each crewman's position.

The procedures which should be followed after ditching are described on the following pages; included are instructions relative to rescue from the water, care of the raft, protection from exposure in various climates, signaling techniques, and raftsmanship. For more detailed instructions on survival at sea, reference should be made to NavAer 00-80T-70.

Rescue From Water

Stay clear of the airplane (out of gas-saturated waters) but in the vicinity until it sinks.

Search for missing men.

Salvage floating equipment; stow and secure all items and check rafts for inflation, leaks, and points of possible chafing. Bail out the raft. Be careful not to snag it with shoes or sharp objects.

In cold oceans, wear an exposure suit, if available. Rig a windbreak, spray shield, and a canopy. If you are with others, huddle together; exercise regularly.

Check the physical condition of all aboard. Give first aid if necessary. Take seasickness pills if available. Wash off gasoline from yourself.

If there is more than one raft, connect rafts with at least 25 feet of line. Connect rafts only at lifeline around outer periphery of the raft. Unless the sea is very rough, shorten the line if an airplane is heard or seen. Two or more rafts tied close together are easier to spot than scattered rafts.

Get the emergency radio into operation. Directions are on the equipment. Use the emergency transceiver only when aircraft are known to be in the area. Prepare other signaling devices for instant use.

Keep compasses, watches, matches, and lighters dry. Place them in waterproof containers.

In warm oceans, rig the sunshade and the canopy. Keep your skin covered. Use sunburn cream and chapstick. Keep your sleeves rolled down and your socks pinned up or pulled up over trousers. Wear a hat and sunglasses.

Make a calm estimate of the situation and plan a course of action carefully.

Ration water and food; assign duties to the crew. Use the canopy or paulins for catching and storing rainwater.

Keep a log. Record the navigator's last fix, time of ditching, names and physical condition of personnel, ration schedule, winds, weather, direction of swells, times of sunrise and sunset, and other navigation data. Inventory all equipment.

Keep calm. Save water and food by saving energy. Do not shout unnecessarily. Do not move around unnecessarily. Keep your sense of humor sharp; use it often. Remember that rescue at sea is a cooperative project. Search aircraft contacts are limited by the visibility of survivors. Increase visibility by using all possible signaling devices. Keep mirrors handy; use the radio whenever possible; use the signal panel and the dye marker when you think an aircraft can see them.

Care of Raft

Be sure that the raft is properly inflated. If main buoyant chambers are not firm, top off with pump or mount inflation tube. See that the valve is open before pumping (to open, turn to the left). Inflate cross seats where provided unless there are injured men who must lie down. Do not overinflate. Air chambers should be well rounded but not drum tight. Close the valve tight. Regularly check inflation. Hot air expands; therefore, on hot days release some air, and add air when the weather cools.

Always throw out the sea anchor or improvise a drag from the raft case, bailing bucket, or roll of clothing. A sea anchor will help you stay close to the ditching site, and the searcher's problem will be easier. Wrap the sea anchor rope with cloth so that it will not chafe the raft.

Be careful not to snag the raft. In good weather, take off shoes; tie them to the raft. Do not let fishhooks, knives, ration tins, and other sharp objects damage the raft. Keep them off the bottom of the raft.

In stormy weather, rig the spray and windshield at once. In a 20-man raft, keep the canopy erected at all times. Keep the raft as dry as possible. Keep it properly balanced. All men should stay seated, the heaviest men in the center.

Leaks are most likely to occur at valves, seams, and underwater surfaces. They can be repaired with the repair plugs provided. Most multiplace rafts have buoyance tubes separated nto two chambers. If one chamber is damaged, keep the other fully inflated.

Secure equipment by lashing it to the raft and storing it in raft pockets and kit containers. Keep these closed when not in use. Keep dry such items as flashlights, signal guns, and flares.

Protection Against Exposure

IN COLD OCEANS.—You must stay dry and keep warm. If you are wet, get down behind the windshield. Remove, wring out, and replace outer garments or get into dry clothing, if possible. Dry your hat, socks, and gloves.

If you are dry, share clothes with those who are wet. Give them the most sheltered positions on the raft. Let them warm their hands and feet against your body.

Put on any extra clothing available. If no exposure suits are provided, drape extra clothng around your shoulders and over your head. Keep your clothes loose and comfortable. Try o keep the floor of the raft dry. For insulation, cover the floor with canvas or cloth.

Huddle with the others on the floor of the raft. Spread extra tarpaulin, sail, or parachute over the group. If you are on a 20-man raft, lower canopy sides. Take mild exercise to restore circulation. Repeatedly bend and open fingers and toes. Exercise shoulders and buttock muscles. Warm hands under armpits. Periodically, raise your feet slightly and hold them up for a minute or two. Move your face muscles frequently to detect frostbite. Shivering is normal—it is the body's way of quickly generating heat.

Give extra rations to men suffering from exposure to cold.

IN WARM OCEANS.—Protection against the sun is most important. Exposure to the sun increases thirst, wasting precious water and reducing the body's water content. The sun also causes serious burns. Improvise and get under a sunshade. If you are on a 20-man raft, erect the canopy and furl the sides. Use the paulin, light side up, to attract attention; blue side up for camouflage in unfriendly waters. In rigging the sunshade, leave space for ventilation. In a 1-man raft, use the spray shield for a sunshade.

Keep the body well covered. Do not throw any clothes away. Roll down your sleeves; pull up your socks. Close your collar. Wear a hat or improvised headgear. Use a piece of cloth as a shield for the back of your neck. Wear sunglasses or improvise eye cover from cloth.

Signaling

One man, a group of men, or even an airplane, is not too easy to spot from the air, especially when visibility is limited. Emergency signaling equipment is designed to make you bigger and easier to find.

EMERGENCY RADIO.—The airplane radio or emergency radio is the best rescue aid. Try to make contact at once. Try to get a fix; if the radio is serviceable, transmit your position. When using the airplane radio, save the battery; try to get an engine or auxiliary generator to operate and charge the battery.

Use smoke by day, bright flame by night. Add engine oil, rags soaked in oil, or pieces of rubber (matting or electrical insulation) to make black smoke; add green leaves, moss, or a little water to send up billows of white smoke. Keep plenty of spare fuel on hand.

Signaling aids, such as flares and smoke grenades, must be kept dry. Use them only when friendly aircraft are sighted or heard.

MIRROR.—Practice signaling with the mirror in the kit. A mirror can be improvised from a ration tin by punching a hole in the center of the lid. Keep the mirror clean. On hazy days, aircraft can see the flash of the mirror before survivors can see the aircraft; so flash the mirror in the direction of the aircraft when it is heard, even when it cannot be seen. (See fig. 3-1.)

PYROTECHNIC PISTOL.—The "pyro pistol," as it is often called, is standard equipment for naval aircraft, including training aircraft, and is used to fire aircraft signals. (See fig. 3-2) Pyrotechnic Pistol AN-M8 is a breech-loading double action signal pistol. The barrel is hinged to the frame and is held in firing position by the breechlock. The plastic grips, backplate, and cover plate fasten to the aluminum frame and act as a housing for the firing mechanism.

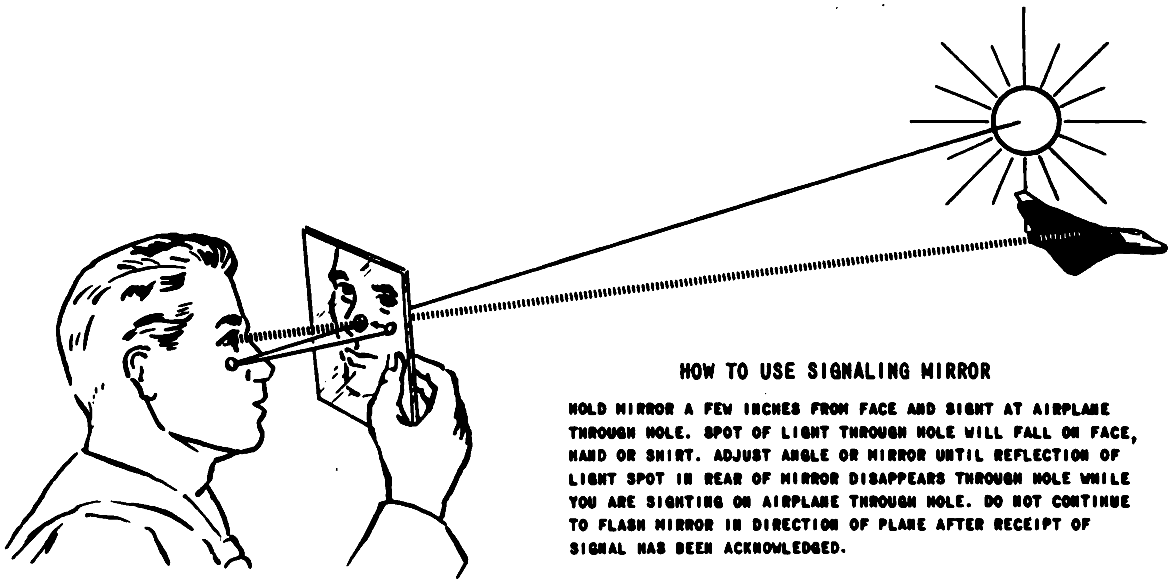
To load the pistol, lift up on the breechlock. This unlocks the breech and swings the breech up. Insert the round and close the breech. CAUTION: When loading and firing, care should be taken never to point the pistol toward other personnel or vessels. The star charges can inflict severe burns or start fires. When firing the pistol by hand, it should be held with the elbow slightly bent to absorb the shock of recoil.

The pistol must be kept in serviceable condition at all times. After each firing, it should be cleaned thoroughly and all principal parts wiped down with an oily cloth. When assembled, the exposed parts should be wiped off with a dry cloth. To remove powder residue, the bore should be swabbed out with a cloth dampened with an approved bore cleaning solvent.

MARK 13 SIGNAL.—The Mk 13 Mod 0 is combination distress signal for either day or night use. Because of its small size and weight, it can be carried in the pockets of lifevests o flight suits and on liferafts. The signal is especially adapted for use by aircraft personne downed at sea. The signal consists of a met cylindrical outer case with each end closed b a soldered cap. Each cap has an attached pu ring large enough for the insertion of the inde finger. The signal has two inner cans—one co tains an orange smoke pyrotechnic and the othe a flare pyrotechnic. A brass pull wire is attached to the bottom of each cap through ignition cap. Both ends of the signal are covere by paper caps to prevent the metal caps fro being pulled off accidentally. (See fig. 3-3.

Instructions for using the signal are printed on the cylindrical outer case. The flare end of the signal (for night use) has raised projection extending around the body about 1/4 inch fro the cap. These serve as an identification that the signal can be correctly operated ev in total darkness. When the "day" end is use orange smoke is emitted; and when the "night end is used, a pyrotechnic candle is lighte Each section of the signal is designed to held comfortably in the bare hand while it functioning. To operate the signal, proceed follows:

1. Determine which end of the signal is be used, and remove the paper cap which is glue to the signal body.



HOW TO USE SIGNALING MIRROR

HOLD MIRROR A FEW INCHES FROM FACE AND SIGHT AT AIRPLANE THROUGH HOLE. SPOT OF LIGHT THROUGH HOLE WILL FALL ON FACE, HAND OR SHIRT. ADJUST ANGLE OR MIRROR UNTIL REFLECTION OF LIGHT SPOT IN REAR OF MIRROR DISAPPEARS THROUGH HOLE WHILE YOU ARE SIGHTING ON AIRPLANE THROUGH HOLE. DO NOT CONTINUE TO FLASH MIRROR IN DIRECTION OF PLANE AFTER RECEIPT OF SIGNAL HAS BEEN ACKNOWLEDGED.

Figure 3-1.—How to use signal mirror.

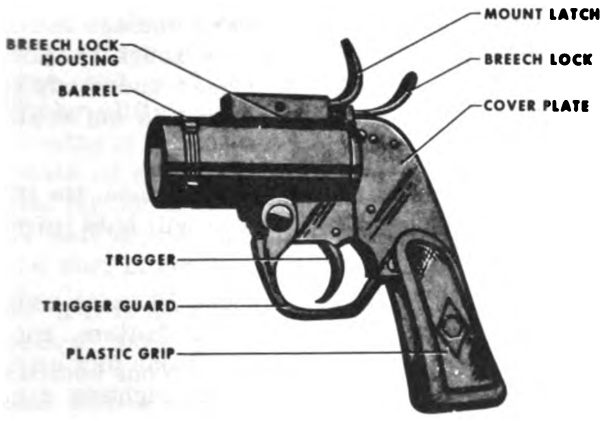


Figure 3-2.—Pyrotechnic pistol.

2. Point the signal away from the face and ive a quick pull on the pull ring, removing the ap and igniting the composition. To break the eal, it may be necessary to bring the pull ring own over the rim of the can and twist it.

3. Douse the signal in water immediately fter use in order to cool the metal parts. The ignal should then be retained for use of the pposite end, if required.

Special safety precautions applicable to the peration of this signal are as follows:

1. Never attempt to ignite both ends of the ignal at the same time.

2. Do not handle the signal roughly.

3. Hold the signal properly to prevent drippings from hitting the hand.

DYE MARKERS.—The dye packet contains a small quantity of crystalline dye compound (3 to 3 1/4 ounces). When the compound is exposed to water it slowly dissolves while producing a brilliant yellowish-green fluorescence. Fluorescin dye is very effective for marking a relatively large area which can surround or trail (depending on sea and weather conditions) personnel who are adrift at sea. Under moderate sea conditions, it takes from 20 to 30 minutes for the dye to dissolve, and after a period of one hour it loses its value completely. Under good conditions and while the marker lasts, it can be seen from a distance of approximately 10 miles at 3,000 feet altitude.

An exterior orange-yellow envelope (6 x 5 x 1 inches) serves the purpose of (1) providing a waterproof container for the dye compound contained in a loosely woven bag; (2) acting as an anchoring point for the dye pouch which is secured to a long tape; and (3) supporting a tape across the top of the envelope which is used to tie the marker to lifevests and other basic items of survival. The accessories container of each size raft is supplied with six markers. Figure 3-4 shows the exterior and interior views of the dye marker.

LIGHTS.—At night use flashlights, recognition light, or the blinker signal light of the radio.

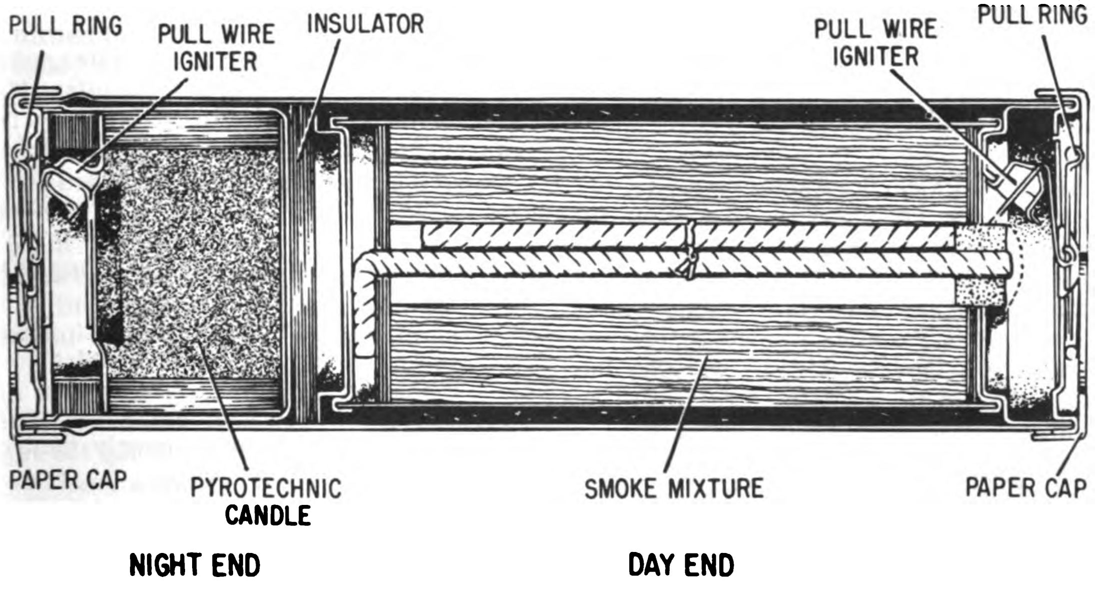


Figure 3-3.—Mk 13 distress signal.

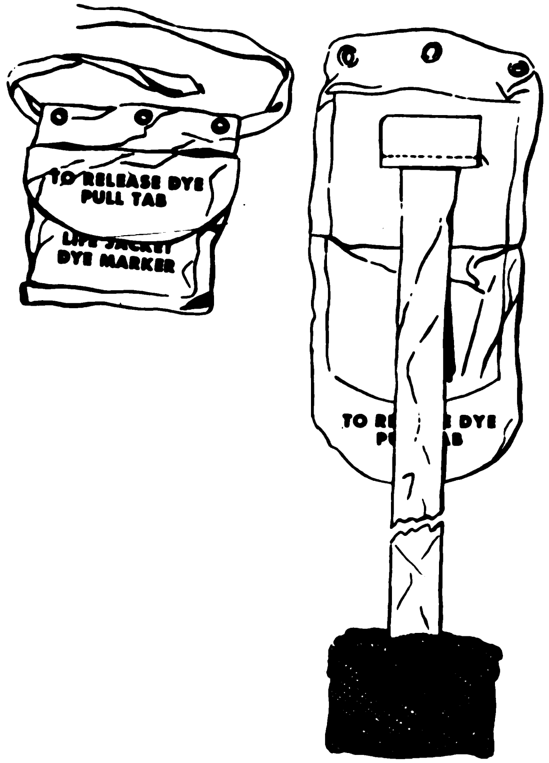


Figure 3-4.—Life jacket dye marker.

Any light can be seen over water for several miles.

WHISTLE.—At night or in fog use the whistle from the emergency kit to attract surface vessels or people on shore, or to locate another raft if it becomes separated.

Raftsmanship

USE OF EQUIPMENT.—Take every precaution to prevent the raft from turning over. In rough weather, keep the sea anchor out from the bow; sit low in the raft, with the passengers' weight distributed to hold the weather side down. Do not sit on the sides or stand up. Never make sudden movements without warning the other men. Do not tie a fishline to yourself or the raft; a large fish may capsize the raft.

In rough seas tie the stern of the first raft to the bow of the second and rig the sea anchor to the stern of the second raft. Use approximately a 25-foot line between rafts; adjust the length of the line to suit the sea. Keep the sea anchor line long; adjust its length so that when the raft is at the crest of a wave, the sea anchor will stay in a trough. In very rough weather, keep a spare sea anchor rigged and ready for instant use in case the one that is out breaks loose.

When the sea anchor is not in use, tie it to the raft and stow it so that it will hold immediately if the raft capsizes.

To right multiplace (except 20-man) rafts, toss the righting rope over the bottom, move around to the other side, place one foot on the flotation tube, and pull on the righting rope. (See fig. 3-5.) If you have no righting rope or if you cannot improvise one from the sea anchor line, a belt, or a shirt, slide up on the bottom, reach across, grab the lifeline on the far side, and then slide back into the water, pulling the raft back and over. Most rafts are equipped with righting handles on the bottom. The 20-man raft is identical on both sides and therefore requires no righting.

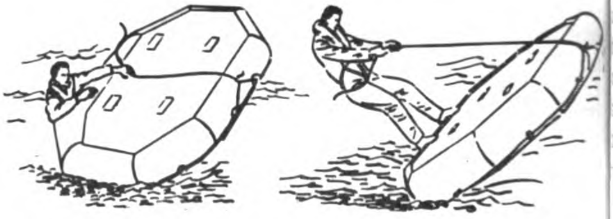


Figure 3-5.—Righting a multiplace raft.

If several men are in the water, one should hold down the far side of the multiplace (4-6 Man) raft while the rest climb in singly from the other side. Grasp the seat to haul yourself in, or use the boarding ladder provided on the newest types of raft. Without help, the best place to board the raft is over the end. If the wind is blowing board the raft with the wind at your back. The 20-man raft is provided with a deflated boarding station, which is hand-inflated after occupants are aboard.

To board the 1-man raft, climb in from the narrow end; slide up as nearly horizontal as possible.

RAFTING ASHORE.—Going ashore in a strong surf is dangerous. Take your time. Select the landing point carefully. Try not to land when the sun is low and straight in front of you. Try to land on the lee side of an island or of a point of land. Keep your eyes open for gaps in the surf line, and head for them. Avoid coral reefs and rocky cliffs. Coral reefs do not occur near the mouths of fresh water streams. Avoid rip currents or strong tidal currents which may carry you far out to sea. Either signal shore for help or sail around and look for a sloping beach where the surf is gentle.

If it is necessary to go through surf to reach shore, take down the raft mast. Keep your clothes and shoes on to avoid severe cuts. Adjust and inflate your lifevest. Trail the sea anchor over the stern with as much line as you have. Use the oars or paddles and constantly adjust the sea anchor to keep a strain on the anchor line. It will keep the raft pointed toward shore and prevent the sea from throwing the stern around and capsizing the raft. Use the oars or paddles to help ride in on the seaward side of a large wave.

Surf may be irregular and velocity may vary, so the procedure must be modified as conditions demand. A good method of getting through surf is to have half the men sit on one side, half on the other, facing each other. When a heavy sea bears down, half should row toward the sea until the crest passes; then the other half should row toward the shore until the next wave comes along.

Against strong wind and heavy surf, the raft must have all possible speed to pass rapidly through the oncoming crest in order to avoid being turned broadside or thrown end over end. If possible, avoid meeting a large wave at the moment it breaks.

In a medium surf with no wind or offshore wind, keep the raft from passing over a wave so rapidly that it drops suddenly after topping the crest.

If the raft turns over in the surf, try to grab hold.

As the raft nears the beach, ride in on the crest of a large wave. Paddle or row hard and ride in onto the beach as far as possible. Do not jump out of the raft until it has grounded. Then get out quickly and beach it.

If you have a choice, do not land at night. If you have reason to believe that the shore is inhabited, lay away from the beach, signal, and wait for the inhabitants to come out and bring you in.

SURVIVAL ON LAND

Parachute Landings

All personnel who fly, frequently or occasionally, should be instructed in parachute landings other than routine landings under ideal conditions. Although routine landings should not be disregarded, special emphasis should be given to high wind landings and landing in trees.

HIGH WIND LANDINGS.—Landing safely with a parachute in high wind is not an easy task. Initial touch down may seriously injure the jumper or make him unconscious, which would make it impossible for him to defend himself. However, proper technique is extremely helpful in reducing the chances of death or injury during high wind landings. The danger lies in the fact that a high wind is capable of keeping the canopy inflated and dragging the jumper across the ground, thus causing serious injury or possibly death. The jumper is responsible for deflating the canopy after landing, so he should be thoroughly indoctrinated in the method of deflating the canopy.

A jumper may elect to unsnap his harness during the descent and allow the harness to pull from his body after touchdown. This unsnapping may only be done if the jumper can move back and sit in the sling of the harness, with no weight on the leg straps. To slide back into the harness sling, grasp the main sling on each side near the seat, apply pressure towards the knees and kick the knees sharply toward the chest. Disconnect the snaps attaching both leg straps first and then the chest snap, but do not remove the arms from the body straps. Grasp the lift webs with each hand and extend the arms over the head and then release the harness at the instant the feet touch the ground. In many cases it is impossible to use this technique due to body configuration, bulky clothes, etc.

A new canopy release has been developed that enables the pilot to disconnect the canopy from his harness as soon as he lands. This new release makes it possible for the aviator to free himself of the canopy without his being dragged over the ground or through the water by the wind. (See fig. 3-6.) This release is used with the integrated torso harness in the A4D, F8U, TT1, A3J, and T2J aircraft.

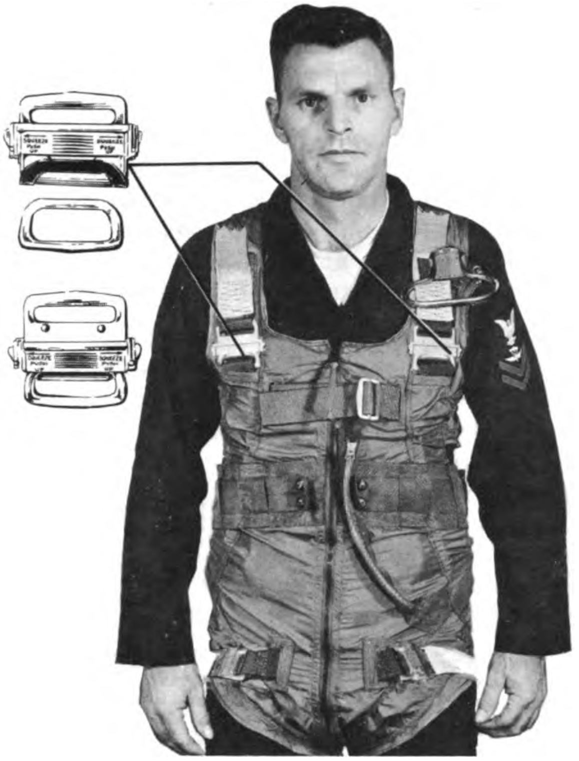


Figure 3-6.—Quick-acting canopy release.

Instructions should be emphasized to never tamper with the safety lock on these ejection snaps during descent. Accidentally releasing the ejection snaps during descent will release the canopy from the harness and the body will be dropped into a free fall.

If the parachute is not equipped with ejection snaps and the jumper cannot safely release the leg snaps, he should be instructed to land with the harness fully snapped. Since unsnapping a harness while being dragged across the ground is next to impossible, collapsing the canopy by deflating can be accomplished regardless of wind velocity if the jumper remains calm and applies the deflating technique with determination. Deflation on land is accomplished by pulling in on any bottom suspension line or group of suspension lines. (See fig. 3-7.)

The deflating process can burn the hands and fingers. The lines should be grasped with a sideward twisting motion of the hands and wrists as each new snubbing grip is made along the lines. After the canopy has been deflated, it is a good practice to sit on the canopy while unsnapping and preparing to slide out of the harness.

Excellent practice can be accomplished deflating a canopy on a windy day. Using a surveyed parachute on an open field, a couple of men can whip the canopy until it is inflated. This will drag the wearer across the ground; and after a few tries, he will be able to deflate the canopy with proficiency. For safety purposes, a few men should be present close to the inflated canopy. In the event the wearer is unable to deflate the canopy on his first try, the canopy can be deflated by a man catching the peak of the canopy and running around into the wind. On some stations, a wind machine is provided for the purpose of deflating canopies under simulated high wind conditions.

TREE LANDINGS.—When landing in trees, do not grasp the risers. Cross the arms in front of the face, and bury the face in the crook of either elbow, as shown in figure 3-8. To protect the hands, place them in the armpits. Keep the feet and knees together until you stop falling. Do not attempt to brake the descent through the trees by grasping at limbs. Take your time in climbing down. If you can, wait for rescue. If you cannot, try to make a rope from the risers and suspension lines of the parachute.

In ground landings at night, prepare for a normal landing as soon as the parachute opens, and be ready for contact at any time. Surprisingly enough, statistics show that fewer men have been injured on night jumps than day jumps. Perhaps because landing is a surprise, the jumper does not have a chance to tense up for the unexpected. If you see that you are going to land in telephone or power wire, which are usually quite high and spaced several feet apart, put the hands above the head, palms flat against the inside of the front risers. Keep the feet and knees together, toes pointed, to avoid straddling a line.

Survival After Crash Landing

GENERAL.—Stay away from the airplane until the engines have cooled and spilled gas has evaporated.

Check injuries. Give first aid. Make the injured men comfortable. Be careful when removing casualties from the airplane, particularly men with injured backs and fractures.

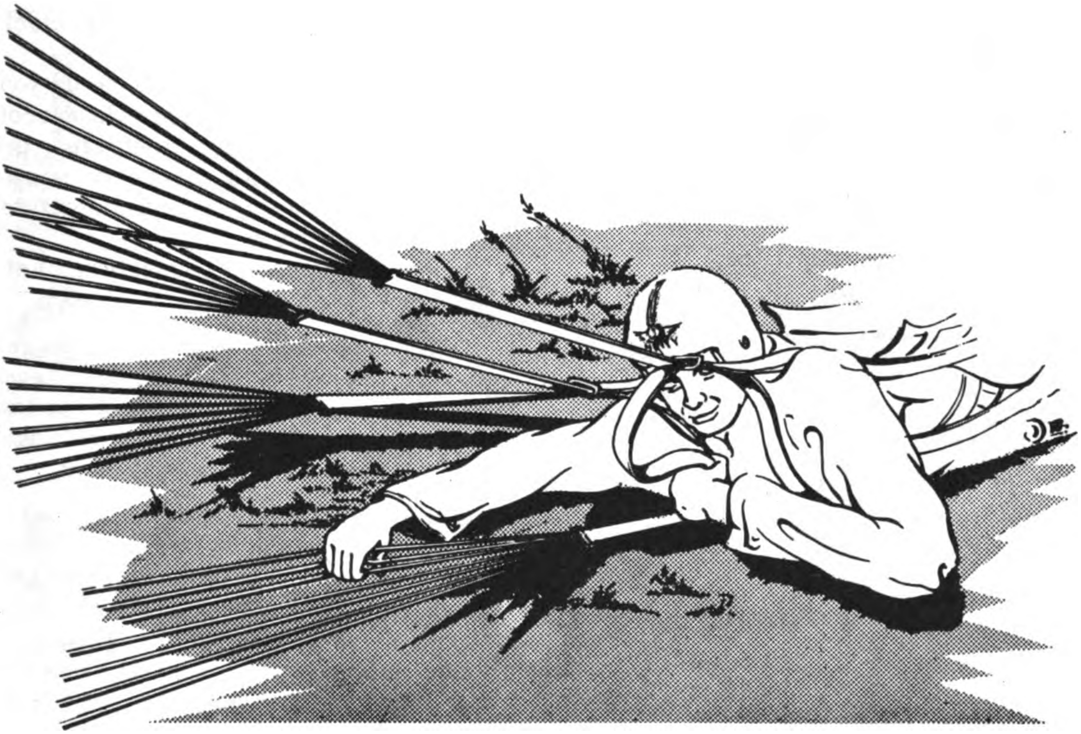


Figure 3-7.—Deflating the parachute canopy.

Set up a temporary shelter for protection from the wind and rain. If a fire is needed, start it at once. In cold weather, make hot drinks.

Get your emergency radio operating on schedule and have other signaling equipment handy.

Now relax and rest until you are over the shock of the crash. Leave extensive preparations and planning until later.

After resting, organize the camp. Appoint individuals to specific duties. Pool all food and equipment in charge of one man. Prepare a shelter for protection from rain, hot sun, snow, wind, cold, or insects. Collect all possible fuel. Try to have at least a day's stock of fuel on hand. Look for a water supply, and for animal and plant food.

Prepare signals in order to be recognized from the air. Place the cloth signal panel in the open where it can be seen. (See fig. 3-9.)

Start a logbook. Include date and cause of crash; probable location; roster of personnel; inventory of food, water, and equipment; weather conditions; and other pertinent data.

Determine your position by the best means available, and include this position in the radio messages. If position is based on celestial observations, transmit the observations also.

If you have bailed out, try to make your way to the crashed airplane. The rescuers can spot it from the air even when they cannot see a man.

Stay with the airplane unless briefing instructions have been to the contrary. Do not leave the airplane unless you know that you are within easy walking distance of help. If you travel, leave a note giving planned route (except in hostile territory). Stick to your plan so rescuers can locate you.

You are the key man in the rescue. Help the search parties to find you and follow their instructions when they sight you. Do not collapse when you are sighted or when the rescue party arrives. They can use all the assistance you can give. Do not take chances which might result in injury. You will be easier to rescue if you are in one piece.

The following procedures will speed up your rescue:

Conserve power of electronic equipment. Use it according to procedures given in your briefing.

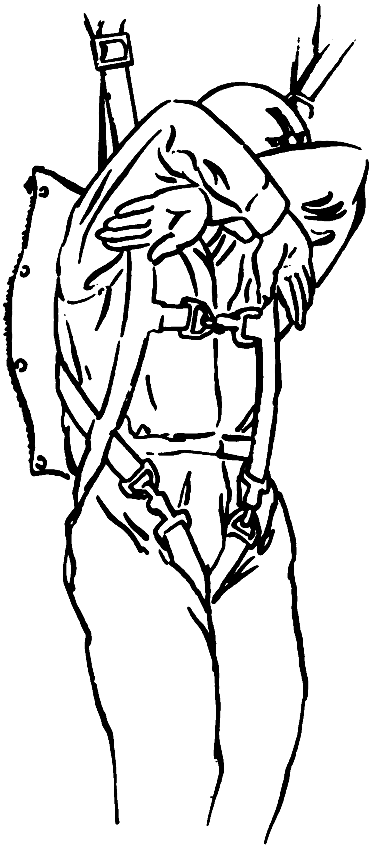


Figure 3-8.—Landing in trees.

Sweep the horizon with your signal mirror at frequent intervals.

ARCTIC.—In winter, protection from cold is the immediate and constant problem. Keep dry, avoid snowblindness, check for frostbite.

To stay dry, keep snow out of your boots, gloves, and clothing; avoid open water. Overexertion causes perspiration which will freeze inside your clothing, thus decreasing effective insulation and increasing the chances of freezing. Always remove outer clothing when working or moving; when you stop, throw your outer garments over your shoulders or replace them to avoid chilling. If you have shelter at night, remove your underclothes and air them, or let them get cold and beat the frost out with a stick. Keep hands and feet dry.

Collect wood, gasoline, oil, heather, brush, or peat for fuel. Build a fire at a safe distance from the airplane and get under shelter.

If the airplane is flyable, drain oil; insulate wheels from ice with boughs or canvas; leave brakes off; remove battery and protect it from freezing.

If down in a glacier area, be on your guard against falling into crevasses when reconnoitering. Rope party together, preferably three men to a rope. As you walk, probe the snow in front of you with a pole or ice ax to detect crevasses covered by thin snow.

In summer, protect yourself against insects. Keep dry.

DESERT.—Water will be your biggest problem. Do not waste it. Keep your head and the back of your neck covered and get into shade as soon as possible to reduce sweating and loss of body water. Travel only at night.

TROPICS.—Take shelter from rain, sun, and insects. Malaria-carrying mosquitoes and other insect pests are the immediate dangers of the tropics—protect yourself against bites.

Do not leave landing site without carefully blazing or marking your route. Use your compass. Know in what direction you are going.

Signaling

Use smoke by day, bright flame by night. Add engine oil, rags soaked in oil, or pieces of rubber (matting or electrical insulation) to make black smoke; add green leaves, moss, or a little water to send up billows of white smoke. Keep plenty of spare fuel on hand.

Signaling aids, such as flares and smoke grenades, must be kept dry. Use them only when friendly aircraft are sighted or heard.

Signal with a flashlight or the blinker signaling light of the emergency radio. If the airplane landing lights are intact and you can get an engine to run, remove the lights and extend them for signaling, but do not waste the battery—save it for the radio.

Place or wave the yellow-and-blue cloth signal panel in the open where it can be seen. Spread out parachutes. Make a pattern of orange-colored Mae Wests. Line up cowl panels from engine nacelles upside down on airplane wings or ground; polish the inside surfaces—they make good reflectors. Arrange your ground signals in big geometric patterns rather than at random—they will attract more attention that way. The radio balloon or kite makes a good signal.

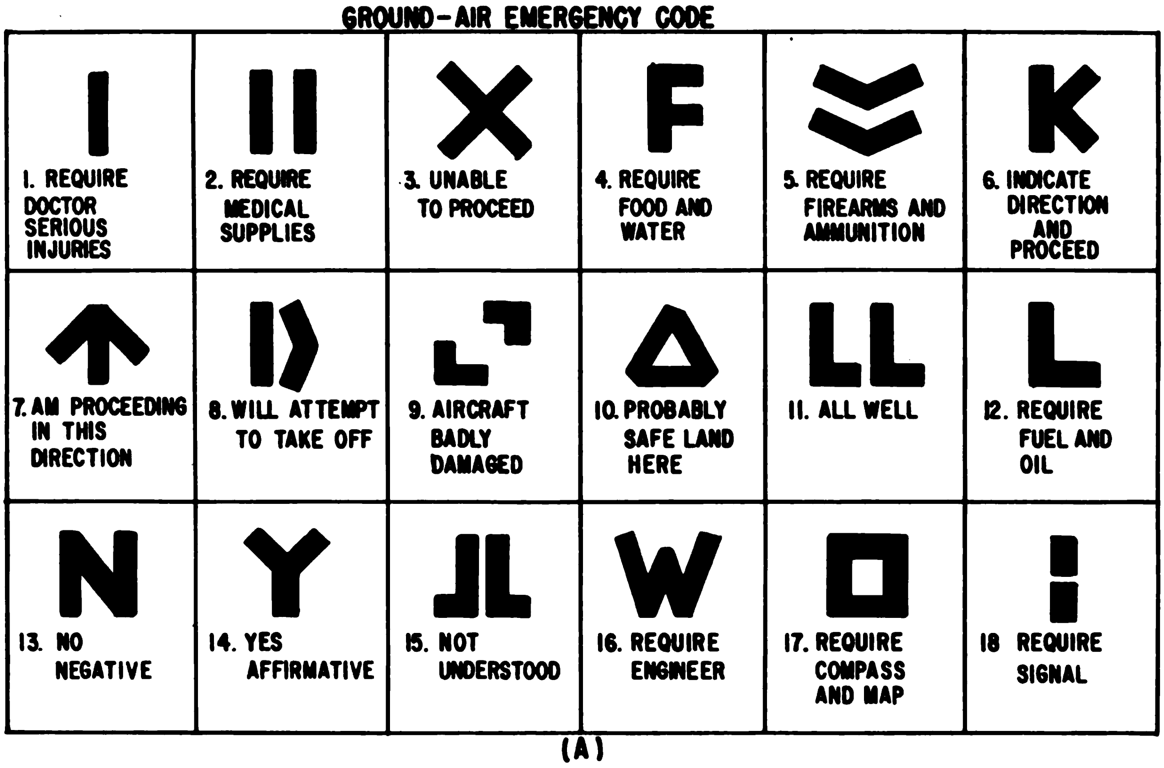

GROUND-AIR EMERGENCY CODE
1. REQUIRE DOCTOR SERIOUS INJURIES
2. REQUIRE MEDICAL SUPPLIES
3. UNABLE TO PROCEED
4. REQUIRE FOOD AND WATER
5. REQUIRE FIREARMS AND AMMUNITION
6. INDICATE DIRECTION AND PROCEED
7. AM PROCEEDING IN THIS DIRECTION
8. WILL ATTEMPT TO TAKE OFF
9. AIRCRAFT BADLY DAMAGED
10. PROBABLY SAFE LAND HERE
11. ALL WELL
12. REQUIRE FUEL AND OIL
13. NO NEGATIVE
14. YES AFFIRMATIVE
15. NOT UNDERSTOOD
16. REQUIRE ENGINEER
17. REQUIRE COMPASS AND MAP
18 REQUIRE SIGNAL
(A)

Figure 3-9(A).—Ground-air emergency code.

Use the fluorescent dye available in the liferaft or Mae West kit for signaling on water or snow. Use it carefully, for a little goes a long way; use it only downwind for the fine dye will penetrate clothing or food. On rivers, throw it out into the current for a quick spread.

ARCTIC.—Keep snow and frost off airplane surfaces to make a sharp contrast with the surroundings. Build your fire on a platform so it will not sink into the snow. A standing spruce tree near timber line burns readily even when green. Build a "birdnest" of quickly flammable material in the branches to insure a quick start.

Tramp out signals in the snow. Fill them in with boughs, sod, moss, or fluorescent dye water.

In brush country, cut conspicuous patterns in vegetation.

In tundra, dig trenches, turn sod upside down at side of trench to widen signal.

A parachute tepee stands out in the forest or on the tundra in summer, especially at night with a fire inside.

Remember, sound does not carry well through snow. If the entire party is in a snow cave or igloo, you may not hear rescue aircraft. Keep someone on guard as a spotter. Build the spotter a windbreak but do not roof it.

DESERT.—A good improvised flare can be made from a tin can filled with sand and soaked with gasoline. Light it with care. Add oil and pieces of rubber to make dense smoke for daytime signal. Burn gasoline or use other bright flame at night.

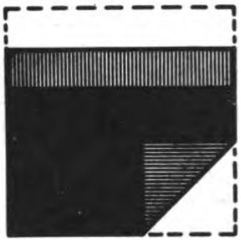
Dig trenches to form signals or line up rocks to throw a shadow.

If there is any brush in the area, gather it in piles and have it ready to light.

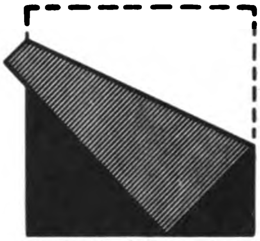
Smoke fires and smoke grenades are best for use in daytime. Flares and bright flames are hard to see.

The mirror is a very good desert signal; practice using it.

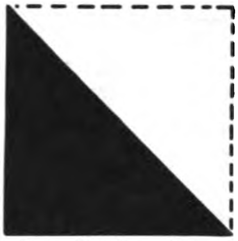
TROPICS.—Set up fires and other signals in natural clearings and along edges of streams,



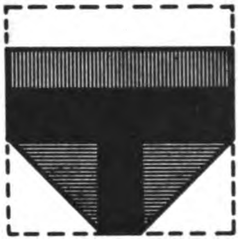
On Land: Walking in this direction
At Sea: Drifting



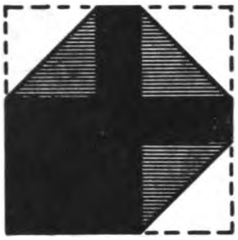
On Land & at Sea { Plane is flyable, need tools



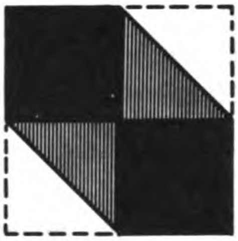
At Sea: Need equipment as indicated. Signals follow.



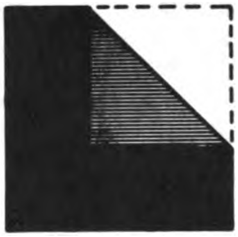
On Land: Need quinine or atrabrine
At Sea: Need sun cover



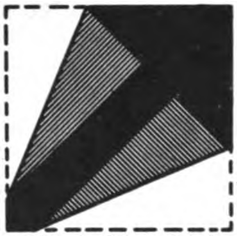
On Land at Sea Need first aid supplies



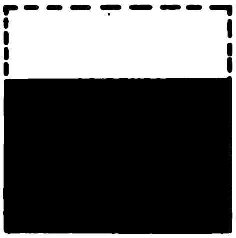
Land & Sea { Do not attempt landing



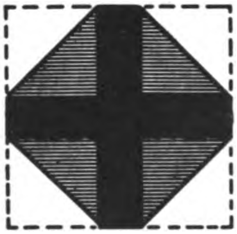
On Land: Need gas and oil, plane is flyable.



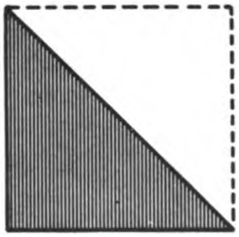
On Land & at Sea { O.K. to land, arrow shows landing direction



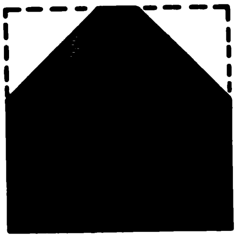
On Land: Should we wait for rescue plane?
At Sea: Notify rescue agency of my position.



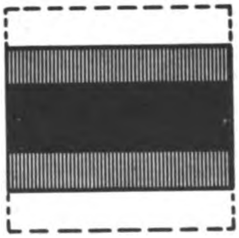
On Land & at Sea { Need medical attention



On Land & at Sea { Need food and water



On Land: Need warm clothing
At Sea: Need exposure suit or clothing indicated



On Land: Indicate direction of nearest civilization.
At Sea: Indicate Direction of rescue craft.

PANEL SIGNALS
Survivors use liferaft sails to convey signals

(B)

Figure 3-9(B).—Ground-air emergency code—Continued.

or make a clearing. Signals under dense jungle growth will not be seen.

Shelter Construction

In any area, a shelter can be improvised from parts of the airplane and emergency equipment or from natural materials in the vicinity.

The kind of shelter that is made depends on whether protection is needed from rain, cold, heat, sunshine, or insects, and also whether the camp is only for a night or for many days.

Choose the location for the camp carefully. Try to be near fuel and water—especially water.

Do not make camp at the base of steep slopes or in areas where you run the risk of avalanches, floods, rockfalls, or battering by winds.

ARCTIC.—In the summer, shelter against rain and insects will be needed. Choose a camp site near water but on high, dry ground if possible. Stay away from thick woods as mosquitoes and flies will make your life miserable. A good camp site is a ridge top, cold lake shore, or a spot that gets an onshore breeze.

If you stay with the airplane, use it for shelter. Cover openings with netting or parachute cloth to keep insects out. Do your cooking outside to avoid carbon monoxide poisoning. Make your fire at a safe distance from the airplane.

Make a simple outdoor shelter by hanging a tarpaulin over the airplane wing; anchor the ends to the ground by weighting them down with stones. A tent can be quickly improvised by placing a rope or pole between two trees or stakes and draping a parachute over it; make the corners fast with stones or pegs.

A fine shelter for drizzly weather and protection against insects is a tepee made from the parachute. In it you can cook, eat, sleep, dress, and make signals—all without going outdoors. Use 6 panels of parachute for a 2-man shelter, 12 to 14 panels for a 3-man paratepee. This shelter is worth building if you decide to stay in one spot for some time.

Avoid sleeping on the bare ground. Provide some sort of insulation under yourself—soft boughs are good. Pick a bed site on level, well-drained ground free from rocks and roots. If you have to sleep on bare ground, dig depressions for your hips and shoulders and try out the site before you set up your shelter or spread your bedding.

In the winter, a shelter against the cold will be needed.

Do not live in the airplane—it will be too cold. Try to improvise a better insulated shelter outdoors.

Camp in timber if possible, to be near fuel. If you cannot find timber, choose a spot protected from wind and drifting snow. Do not camp at the bases of slopes or cliffs where snow may drift heavily or come down in avalanches.

In timbered country, a good winter shelter is a lean-to. Lay the covering boughs shingle-fashion, starting from the bottom. If you have a canvas, use it for the roof. Close the ends with fabric or boughs.

Keep the front openings of all shelters crosswind. A windbreak of snow or ice blocks set close to the shelter is helpful.

In making shelters, remember that snow is a good insulator.

In timberless country, make a simple snow cave or burrow by digging into the side of a snowdrift and lining the hole with grass, brush, or tarpaulin. Snow caves must be ventilated. If the snow is not deep anough to support a roof, dig a trench in a drift and roof it with snow blocks, tarpaulin, or other materials.

In wooded country, make a tree-pit shelter if snow is deep enough. Enlarge the natural pit around a tree trunk and roof it with any available covering.

Reconnoiter for cabins and shelter houses. They are likely to be located along bigger streams, at river junctions, along blazed trails in thick, tall timber leeward of hills.

Prevent carbon monoxide poisoning by providing good ventilation in closed shelters in which a fire is burning.

Do not sleep directly on the snow. Provide insulation under your sleeping bag or body. Lay a thick bough bed in shingle-fashion, or use sea cushions, tarpaulins, or even an inverted and inflated rubber liferaft if available.

Keep your sleeping bag clean, dry, and fluffed up to give maximum warmth. To dry the bag, turn it inside out, beat out frost, and warm it before the fire—but do not burn it. Wear only dry clothes to bed. Keep them loose. Turn over with rather than in the sleeping bag.

DESERT.—In the desert, a shelter mostly from sun and heat will be needed. Use whatever natural shade you can find, such as a cave, rock ledge, or wall of a dry stream bed. A dry canyon in the desert is a dangerous camping ground; cloudbursts may cause sudden and violent floods which sweep along a dry valley in a wall of roaring water.

Do not use the inside of the airplane for shelter in the daytime—it will be too hot. Get under the shade of a wing if you have no other shelter.

If you stay with the airplane, a good shade-shelter can be made easily by tying a spread-out parachute as an awning to the wing, leaving the lower edge at least 2 feet clear of the ground for air circulation. Use sections of airplane tubing for tent poles and pegs. Make sure the airplane is securely moored and the wing solidly guyed to prevent movement in a storm.

If the airplane is not available, make a shelter of your parachute. Two layers of cloth separated by several inches of airspace are cooler than a single thickness.

In winter months and especially at night, desert temperatures may drop to freezing and heavy rains may sometimes occur. Use the inside of the airplane for protection from cold and rain. Do your cooking outside to prevent carbon monoxide poisoning.

TROPICS.—In the tropics try to pick a camp site on a knoll or high spot in an open place well back from swamps. You will be bothered less by mosquitoes, the ground will be drier, and there will be more chance of a breeze.

Do not build a shelter under large trees or trees with dead limbs. They may fall and wreck the camp or hurt someone. Do not sleep or build a shelter under a coconut tree.

In the wet jungle forest, a shelter from dampness will be needed. If you stay with the airplane, use it for shelter. Try to make it mosquito-proof by covering openings with netting or parachute cloth.

The easiest improvised shelter is one made by draping a parachute or tarpaulin over a rope or vine stretched between two trees or by propping it up on poles.

A good rain shelter can be made by covering an A-type framework with a good thickness of palm or other broad leaves, pieces of bark, or mats of grass. Lay the thatch shingle-fashion with the tips of leaves pointing downward, starting from the bottom and working up, so the rain will shed off.

Dig a small drainage ditch just inside the eaves of your shelter and leading downhill—it will help keep the floor dry.

Do not sleep on the ground. Contact with the ground will chill you.

Fire Making

You may need fire for warmth, for keeping dry, for signaling, for cooking, or for purifying water by boiling. Follow the tried and proved advice below.

Do not build the fire too big. Small fires require less fuel and are easier to control; and their heat can be concentrated. In cold weather small fires arranged in a circle are much more effective than one large fire.

PREPARING FIREPLACE.—Prepare the location of the fire carefully. Clear away leaves, twigs, moss, and dry grass, so that you do not start a grass or forest fire. If the ground is dry, scrape down to the bare dirt. If the fire must be built on snow or ice or wet ground, build a platform of logs or flat stones.

To get the most warmth and to protect the fire from wind, build it against a rock or wall of logs which will serve as a reflector to direct the heat into your shelter. Cooking fires should be walled in by logs or stones, not only to concentrate the heat but also to provide a platform for the cooking pot.

KINDLING AND FUEL.—Most fuels cannot be started burning directly from a match. Some easily flammable kindling to start the fire burning will be needed. Good natural kindling materials are thin sticks of dry wood, dry bark, wood shavings, palm leaves, twigs, loose ground-lying lichens, dead, upright grass straw, and ferns. If sticks are used for kindling, split them and cut long thin shavings; leave the shavings attached. Crumpled paper or empty waxed ration boxes are good kindling. Store kindling in shelter to keep dry. A little gasoline poured on the fuel before it is lighted will help it start burning. Do not pour gasoline on a fire already started even if it is only smoldering.

For fuel, use dry standing dead wood and dry dead branches. Dead wood is easy to split and break—pound it on a rock. The inside of fallen tree trunks and large branches may be dry even if the outside is wet; use the heart of the wood. Almost anywhere, green wood that will burn can be found, especially if finely split.

In treeless areas, find other natural fuels, such as dry grass which can be twisted into bunches, peat dry enough to burn (found at the top of undercut river banks), dried animal dung, animal fats, and sometimes even coal, oil shale, or oil sand lying on the surface. If no natural fuels are available, and you are with the airplane, burn gasoline and lubricating oil or a mixture of both.

FIRE MAKING WITH MATCHES AND LIGHTER.—Prepare a fireplace. Get all materials together before trying to start the fire. Make sure the matches, kindling, and fuel are dry. Have enough fuel on hand to keep the fire burning. Arrange small amount of kindling in a low pyramid, close enough together so flames can lick from one piece to another. Leave a small opening for lighting.

Save matches by using a candle (if you have one) to light the fire. If you have no candle, use a "shave stick," or make a fagot of thin, dry twigs, tied loosely. Shield the match from the wind, and light the candle or fagot. Apply the lighted candle or fagot to the lower windward side of the kindling, shielding it from the wind.

Small pieces of wood or other fuel can be laid gently on the kindling before lighting or can be added after the kindling begins to burn. Lay on smaller pieces first, adding larger pieces of fuel as the fire takes hold. Do not smother the fire by crushing down the kindling with heavy wood. Do not make the fire too big. Do not waste fuel.

FIRE MAKING WITH SPECIAL EQUIPMENT.—If you have a fusee signal flare in your kit, light it by striking the self-contained flint and steel. Although it may mean wasting a signal, a fire can be lighted from the flame.

Some emergency kits contain small fire starters, cans of special fuels, windproof matches, and other aids.

FIRE MAKING WITHOUT MATCHES.—First, find or prepare one of the following kinds of tinder: very dry powdered wood, finely shredded dry bark, or the shredded pith of a dead palm frond; lint from unraveled cloth, cotton, twine, rope, or first-aid gauze bandage, fuzzy or woolly material scraped from plants; fine bird feathers or birds' nests; field-mouse nests, or fine wood dust produced by insects, often under bark of dead trees. Tinder must be bone-dry. Make it burn more easily by adding a few drops of gasoline or by mixing in with powder taken from a cartridge. Once tinder is prepared, put some in a waterproof container for future use.

Once you have the tinder, light it in a place sheltered from the wind. Several additional methods of starting a fire are described in the following paragraphs.

FLINT AND STEEL.—This is the easiest and most reliable way of making a fire without matches. Use the flint fastened to the bottom of the waterproof match case. If you have no flint, look for a piece of hard rock from which you can strike sparks. If it breaks or scars when struck with steel, throw it away and find another. Hold your hands close over the dry tinder; strike flat with a knife blade or other small piece of steel, with a sharp, scraping, downward motion so that the sparks fall in the center of the tinder. The addition of a few drops of gasoline before striking the flint will make the tinder flame up—for safety, keep your head to one side. When the tinder begins to smolder, fan it gently into a flame. Then transfer the blazing tinder to the kindling pile or add kindling gradually to the tinder.

BURNING GLASS.—Any convex lens 2 inches or more in diameter can be used in bright sunlight to concentrate the sun's rays on the tinder and start it burning.

FRICTION.—There are many methods of making fire by friction (bow and drill, fire plough, fire thong, etc.), but all require practice. If you are proficient in one of these methods, use it, but remember that flint and steel will give the same results with less work.

ELECTRIC SPARK.—If you are with the airplane, and have a live storage battery, direct a spark onto the tinder by scratching the ends of wires together to produce an arc.

BURNING AIRPLANE FUEL.—If you are with the airplane, you can improvise a stove to burn gasoline, lubricating oil, or a mixture of both. Place 1 to 2 inches of sand or fine gravel in the bottom of a can or other container and add gasoline. Be careful when lighting; the gas may explode at first. Make slots at the top of the can to let flame and smoke out, and punch holes just above the level of the sand to provide a draft. To make a fire burn longer, mix gasoline with oil. If there is no can, simply dig a hole in the ground, fill it with sand, pour on gasoline, and light; take care to protect your face and hands.

You can use lubricating oil for fuel with a wick arrangement. Make the wick of string, rope, rag, or even a cigarette, and rest it on the edge of a receptacle filled with oil. Also, soak rags, paper, wood, or other fuel in oil and throw them on the fire.

A stove can be made of any empty waxed ration carton by cutting off one end and punching a hole in each side near the unopened end. Stand the carton on the closed end; stuff an empty sack loosely inside the carton, leaving an end hanging over the top; light this end—the stove will burn from top down and will boil more than a pint of water.

USEFUL HINTS.—Do not waste matches by trying to light a poorly prepared fire. Do not use matches for lighting cigarettes; get a light from the fire or use a burning lens. Do not build unnecessary fires; save your fuel. Practice primitive methods of making fires before all the matches are gone.

Carry some dry tinder with you in a waterproof container. Expose it to the sun on dry days. Adding a little powdered charcoal will improve it. Collect good tinder wherever it can be found.

Collect kindling along the trail before making camp. Keep firewood dry under shelter. Dry damp wood near the fire so it can be used later. Save some of the best kindling and fuel for quick fire making in the morning.

To split logs, whittle hardwood wedges and drive them into cracks in the log with a rock or club; split wood burns more easily.

To make a fire last overnight, place large logs over it so that the fire will burn into the heart of the logs. When a good bed of coals has been formed, cover it lightly with ashes and then dry earth. In the morning the fire will still be smoldering.

Fire can be carried from one place to another in the form of a lighted punk, smoldering coconut husk, or slow-burning coals. When you want a new fire, fan the smoldering material into flame.

Do not waste fire making materials. Use only what is necessary to start a fire and to keep it going for the purpose needed. Put out the fire when you leave the camp site.

ARTIC.—Do not build a fire under a snow-covered tree—snow may fall and put out the fire.

Low, dead, needle-bearing branches of standing spruce trees are good fuel. On the tundra, wood is scarce. Look for any woody bush or shrub; burn roots as well as stems. Look for dry twigs in willow thickets, or for dry grasses. On the coasts, look for driftwood.

Animal fat and bones can be used as fuel. Put chunks of fat on a stick or bone framework or on top of a perforated can with a wick of greasy cloth or Sphagnum moss underneath, and light the wick. Congealed oil can be burned in the same way.

A candle burning in a tin can makes a simple heater for the shelter.

In cold weather, drain oil from the airplane and store it for fuel. If the temperature is not low enough to solidify the oil, leave it in the airplane and drain it off when needed.

DESERT.—In some deserts fuel is extremely scarce. Wherever you find plant growth, utilize all twigs, leaves, stems, and underground roots for burning. Dry animal dung, more commonly found along traveled routes, gives a very hot flame.

TROPICS.—In the tropics, wood is plentiful—even if it is wet outside, the heart of dead wood will be dry enough to burn. Dry wood can also be found hanging in the network of vines or lying on bushes.

In palm country, good tinder can be obtained by using the fibers at the bases of palm leaves. The insides of dry termite nests make good kindling.

Green leaves thrown on a fire make a smudge that will help keep off mosquitoes.

Keep spare wood dry by stowing it under the shelter. Dry out wet kindling and fuel near the fire for future use.

Survival Weapons

The shotgun load for the survival rifle/shotgun has an effective range of 15 yards against birds and an effective range of 10 to 15 yards against small animals. Do not waste ammunition on long shots, especially long wing shots.

The survival rifle can kill at ranges over 200 yards but chances of hitting game in a vital spot at ranges over 100 yards are very slight.

Remember, most big game is actually killed at ranges under 60 yards. Unless it is impossible to secure a clean kill by closer stalking, never attempt to kill by shooting over 100 yards. Make sure of your first shot, for it may be your last one at that particular animal—and your mmunition supply is what you are carryng.

Follow these rules when hunting:

1. Get as close as possible to the game beore shooting.
2. Do not shoot rapid fire. One shot will do he job if aimed properly.
3. Fire from as steady a position as possible. emember, survival rifles are light and any unteadiness on your part due to exertion or exitement will set the barrel to trembling. The rone position is best for a steady shot, but itting or kneeling positions may have to be used. se a rest such as a log or stone for the barrel henever possible; but put your hand between e rest and the gun barrel or the gun will shoot ild. Never fire offhand unless time prevents our taking another position.
4. Aim at a vital spot. The shoulder or hest is probably the best spot for medium and rge game. Do not shoot unless a vital spot is pen.
5. Do not trust your first shot even if game ppears to have fallen dead. Reload immediately, ut keep your eye on the game.
6. Look for blood if game runs away after e first shot. If blood is found, wait 30 minutes efore following. Wounded game will lie down nd stiffen if given time.

During the winter, remove all lubricants and ust prevention compounds from weapons. Strip em completely and clean all parts with a solent. Gasoline or lighter fluid may be used if vailable. Normal lubricants thicken in cold eather and slow down the action. In cold eather, weapons function best when absolutely ry.

A major problem is to keep snow and ice out f the working parts, sights, and barrel. Even small amount of ice or snow may disable the eapon, so careful handling is essential, espeially in snow. Improvise the muzzle and breech overs, and use them. Carry a small stick in our pocket to clean the sights and breechblock.

Weapons sweat when they are brought from xtreme cold into a heated shelter; and when they re taken out again into the cold, the film of ondensation freezes. This ice may seriously ffect their operations; so leave them outdoors r store them in unheated shelters. If the sheler is not greatly warmer than the outside temerature, bring the weapons inside; but place hem at or near floor level, where the temperature is lowest. When the weapons are taken into a heated shelter for cleaning, remove all the condensed moisture before cleaning. They may sweat for an hour.

If a part becomes frozen, do not force it. Warm it slightly, if possible, and move it gradually until unfrozen. If it cannot be warmed, try to remove all visible ice or snow and move it gradually until action is restored.

Before loading the weapon, always move the action back and forth a few times to insure that it is free and to check the ammunition.

If the weapon has a metal stock, pad it with tape or cloth, or pull a sock over it to protect your cheeks.

Cutting tools are important aids to survival in any environment. For best results, use them and care for them properly.

When using an ax, do not try to cut through a tree with one blow. Rhythm and aim are more important than force. Too much power behind a swing interferes with your aim. When the ax is swung properly, its weight will provide all the power needed.

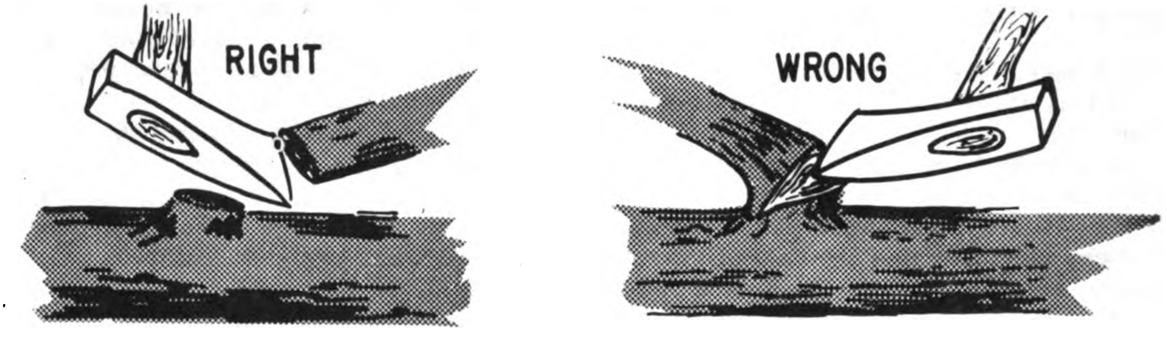
Before doing any chopping, clear away all obstructions. A branch, vine, or bush can deflect an ax onto your foot or leg. Remember, an ax can be a wicked weapon. Figure 3-10 illustrates correct usage of the ax.

A broken handle is difficult to remove from the head of the ax. Usually the most convenient way is to burn it out. For a single-bit ax, bury the blade in the ground up to the handle, and build a fire over it. For a double-bit, dig a little trench, lay the middle of the ax over it, cover both bits with earth, and build the fire.

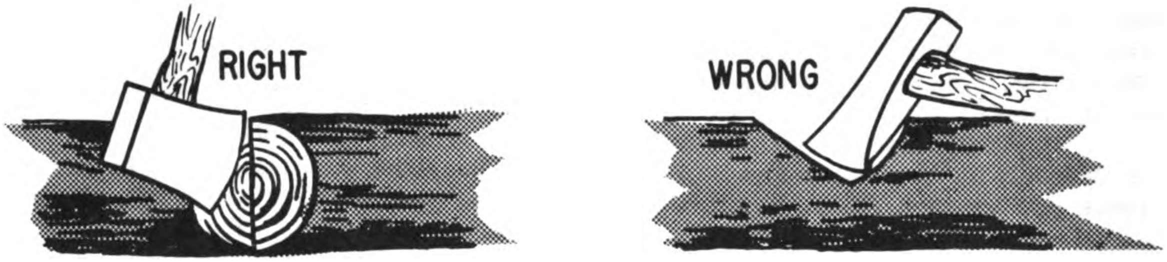
If you have to improvise a new handle, save time and trouble by making a straight handle instead of a curved one like the original. Use a young, straight hardwood without knots. Whittle it roughly into shape and finish it by shaving. Split the end of the handle that fits into the axhead. After it is fitted, pound a thin, dry hardwood wedge into the split. Use the ax awhile, pound the wedge in again, then trim it off flush.

The survival kit may include a file or a whetstone. If you have no sharpening tool, look for a natural whetstone. It will be needed to sharpen your knives and axes.

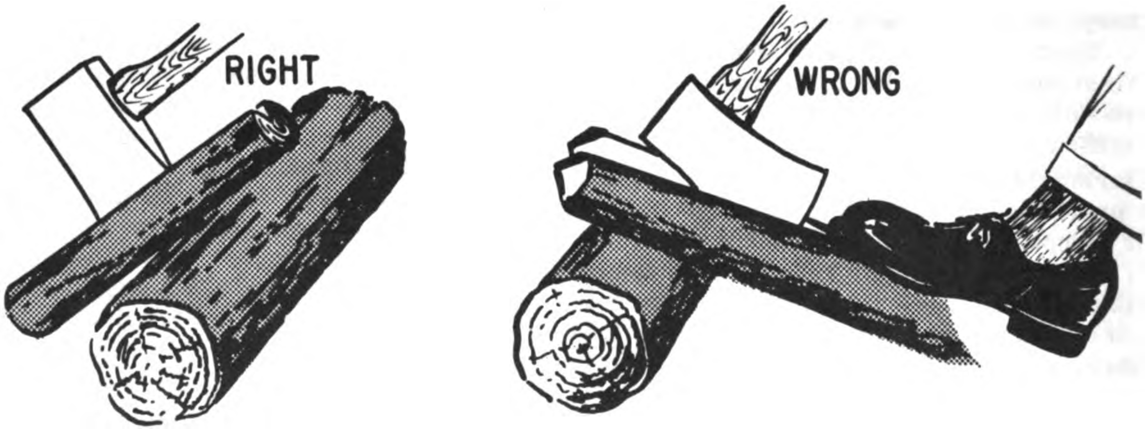
Any sandstone will sharpen tools; but a gray, somewhat clayey sandstone gives better results than a pure quartz. Quartz can be recognized



CUTTING OFF BRANCHES



CUTTING UP LOGS



SPLITTING LOGS

Figure 3-10.—Proper use of axes.

instantly by scratching the knife blade with it—quartz is the only common mineral that will bite into steel, cutting a bright groove with every grain.

If sandstone cannot be found, look for granite or any glittering, crystalline rock except marble. If granite is used, rub two pieces of the stone together until they are smooth before using one as a grindstone.

Axes can be sharpened best by using both file and whetstone, but a stone alone will keep the ax usable. Use the file every few days, the whetstone after each using.

FIELD MAINTENANCE.—Survival weapons are built to withstand survival conditions, but they do require intelligent care if they are to function when needed.

Keep weapons clean and protected when not in use. Keep the action, receiver walls, bolt and assembly, and especially the barrel clean and free from oil, dirt, snow, or mud. If the barrel is obstructed by mud, snow, or any foreign substance, clean it out before shooting. Never try to shoot out an obstruction. The barrel will burst.

Do not use a weapon as a club, hammer, or pry bar. It is a precision-made instrument on which your life may depend.

Do not over-oil a weapon. Only a few drops on moving parts are needed.

A piece of cloth on a string pulled through the barrel is a handy substitute for a ramrod and cleaning patch.

If the barrel must be given a thorough cleaning and no powder solvent is available, pour boiling water through it from the breech. Mop up the excess water by pulling a cloth on a string through the barrel and the hot barrel will dry itself.

Clothing

Think twice before discarding any clothing. Clothing used properly can keep you cool as well as warm. It protects also against sunburn, insects, pests, and scratches. It can be used for barter.

Try to keep clothing clean and in repair. Clean clothes are better insulators than dirty clothes and they last longer.

Try to keep clothing and shoes dry; use a drying rack in front of a fire. Do not put wet shoes too close to the fire or they will stiffen and crack.

ARCTIC.—It is important to wear clothing properly to keep warm and dry.

Insulation combined with body heat is the secret of warmth. Insulation is largely determined by the combined thickness of all the garments worn. Outer clothing should be windproof.

Avoid sweating—it is dangerous because it leads to freezing. When exerting yourself, cut down sweating by opening the clothes at the neck and wrists and loosening at the waist. If you are still warm, remove mittens and headgear, or take off a layer or two of outer clothing. When you stop work, put your clothes on again to prevent chilling.

Wear clothing loosely. Tight fits cut off circulation and increase danger of freezing. Keep ears covered with scarf.

Do not get your boots too tight by wearing too many socks.

If you have no socks and your boots are big enough, stuff dry grass or kapok from airplane cushions around your feet—it will collect the frost and make fine insulation against cold. To maintain the insulation value, dry the material and fluff it up when it becomes compacted.

Felt boots, mukluk boots, or moccasins with the proper socks and insoles are best for dry cold weather; shoepacs (rubber bottomed, leather-topped boots) are best for wet weather.

If you lose your boots or if your socks are wet and you have no spares, improvise footgear by wrapping parachute cloth lined with dry grass or kapok around your feet.

Keep clothing as dry as possible. Brush snow from clothes before entering a shelter or going near a fire. Beat out frost before warming garments—dry them on a rack before the fire. Dry socks thoroughly. Do not get boots too near the fire. Frozen boots or shoepacs are unmanageable.

Wear one or two pairs of wool mittens inside a windproof shell. Try to do everything while wearing the mittens. If you have to remove the mitts, warm your hands inside your clothes—once they get too cold you are in trouble.

Wear sunglasses or improvise a pair to prevent snowblindness.

Keep clothing as clean as possible. Replace missing buttons and repair holes promptly.

In strong wind or extreme cold, wrap yourself in your parachute and get behind shelter.

At night, arrange dry spare clothing loosely around your shoulders and hips—it will help keep you warm.

If you fall in water, roll in dry snow to blot up moisture. Roll, then brush off snow. Roll again, until all water is absorbed. Do not take off shoes until you are in shelter.

DESERT.—Wear clothing for protection against sunburn, heat, sand, and insects. Keep the body and head covered during the daytime.

Wear long pants and shirts with sleeves rolled down. Keep them loose and flapping to stay cooler.

Wear a cloth neckpiece to cover the back of the neck from the sun. If you have no hat, make a headpiece like that worn by the Arabs. (See fig. 3-11.) A pilot chute is adaptable as a parasol for use in the desert; do not be too proud to use one. During dust storms, wear a covering for the mouth and nose; parachute cloth will do.

If you have lost your shoes or they wear out, make sandals as illustrated in figure 3-11.

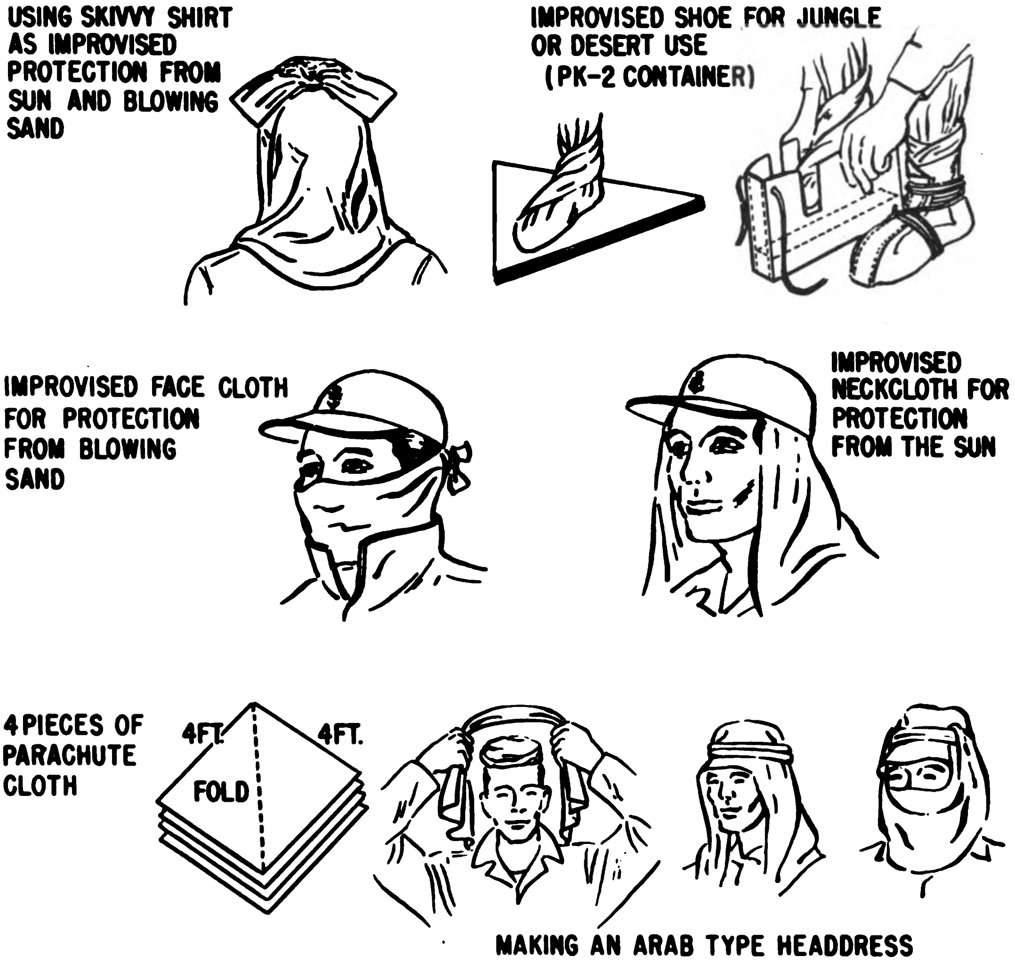

USING SKIVVY SHIRT AS IMPROVISED PROTECTION FROM SUN AND BLOWING SAND
IMPROVISED SHOE FOR JUNGLE OR DESERT USE (PK-2 CONTAINER)
IMPROVISED FACE CLOTH FOR PROTECTION FROM BLOWING SAND
IMPROVISED NECKCLOTH FOR PROTECTION FROM THE SUN
4 PIECES OF PARACHUTE CLOTH
4FT.
4FT.
FOLD
MAKING AN ARAB TYPE HEADDRESS

Figure 3-11.—Improvised protective clothing for jungle or desert.

TROPICS.—Keep your body covered to (1) prevent malaria-carrying mosquitoes and other pests from biting you; (2) protect your skin against infections caused by scratches from thorns or sharp grasses; and (3) prevent sunburn in open country.

Wear long pants and shirts with sleeves rolled down. Tuck your pants in the tops of your socks and tie them securely, or improvise puttees of canvas or parachute cloth to keep out ticks and leeches.

Loosely worn clothes will keep you cooler.

Wear a mosquito headnet or tie an undershirt or tee shirt around your head. Wear it especially at dawn and dusk.

In open country or in high grass country, wear a neckcloth or improvised head covering for protection from sunburn and dust. (See fig. 3-11.) Move carefully through high grass; some sharp-edged grasses can cut your clothing to shreds.

If you lose your shoes or they wear out, you can improvise a practical pair of sandals by using the rubber sidewall of a tire or a piece of bark for the soles, with parachute cloth or canvas for the uppers and heel straps.

Dry clothing before nightfall to avoid discomfort from cold.

If you have an extra change of clothes, especially socks, keep them dry to replace wet clothing.

Wash clothing, especially socks, daily. Dirty clothes not only rot but may lead to skin diseases.

AIR-SEA RESCUE EQUIPMENT

Other than the standard items which are part of the aircraft's inventory, the Navy has provided various droppable kits to be used for air-sea rescue. Some of these kits can be dropped in free-fall fashion, while others are too fragile for such rough treatment, and must be delivered by small cargo type parachutes. There is no physical limit to the different kinds of equipment that can be rigged for emergency rescue operation. The mental limit, to a great extent, depends on the Parachute Rigger and how well he has prepared himself to cope with emergency rescue techniques.

There are a number of tailormade droppable kits available through Supply. Descriptions of some of these kits, along with information concerning operation of the equipment, are included in this section.

ADSK-2 (Air Droppable Survival Kit)

The ADSK-2 consists of an assortment of survival equipment packed into an interior fabric container, and stowed within a metal outer container equipped with a 12-foot flat parachute for dropping from an aircraft in flight to survivors. The interior fabric container is constructed of a rubber-coated nylon cloth fabric, and is equipped with a continuous slide fastener that runs from the top of one side of the container down, around the bottom, and up to the top of the other side. When fully packed, the fabric container is approximately 13 inches in diameter and 36 inches in length.

The outer metal container consists of a steel cylindrical body assembly with a rounded nose, a parachute stowage pan assembly, a metal cover plate, and a cable lanyard assembly for securing the cover plate. The outer metal container assembly is 14 inches in diameter and has an overall length of approximately 40 inches. The parachute is a 12-foot flat canopy type, constructed in accordance with Naval Parachute Unit Drawing 53-198.

Aviation Clothing and Survival Bulletin No. 29-58 gives a complete description of the ADSK-2 and lists the survival equipment to be carried in the kit. This instruction should be read and used by all personnel concerned with outfitting the ADSK-2 Air Droppable Survival Kit.

AR-4 Lifeboat

The AR-4 droppable lifeboat, designed for dropping to personnel, is a 4-man pneumatic liferaft of double tube construction. It is complete with a lateen type sailing rig, mast, rudder, keel, weather shield, sun canopy, sea anchor, and an inflatable floor. The weight of the unit, properly padded and protected for dropping, and ready for installation in the aircraft, is approximately 110 pounds. An instruction booklet is provided with each assembly, stowed in the starboard bow supply pocket. The booklet contains complete instructions for operating the boat, including all equipment. Figures 3-12 and 3-13 illustrate the AR-4 assembly.

A two-compartment removable inflatable floor is inflated through the topping-off valves provided. The size of the floor is designed so that it will not chafe the flotation tube of the boat. Removed, it can be used as an auxiliary means of flotation. A description of the lifeboat equipment follows:

CO_2 SYSTEM.—Only the main flotation tube is inflated with CO_2. The remaining inflation chambers must be inflated with hand pumps. A wrench, suitable for detaching the CO_2 cylinder from the boat, is securely attached adjacent to the cylinder.

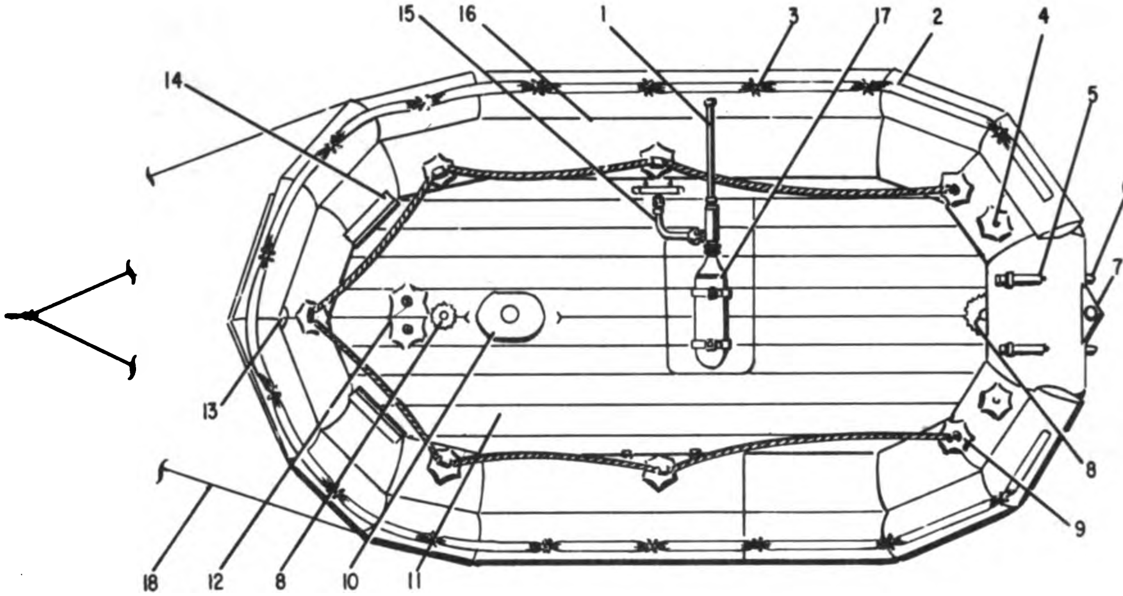
SAILING RIG.—A mast yardarm is formed from sections of oars which are the same as those used in the standard type multiplace rafts. Oar sections necessary for forming the mast yardarm are as follows:

OAR AND SECTION	NO. REQUIRED
6-ft. oar (Section A)	2
6-ft. oar (Section B)	6
6-ft. oar (Section C)	2

The mast is made up of 1 section A length and 2 section B lengths. The yardarm consists of 1 section A length and 4 section B lengths. Section C lengths are used with any of the other sections when paddles are needed.

MAST STAY AND HALYARD FITTING.—One wooden fitting is supplied to fit the top of the mast to hold the three mast stays and receive the halyard as shown in figure 3-13.

D-RING ASSEMBLIES FOR MAST STAYS.—These assemblies consist of 1 1/4 inch cadmium-plated D-rings secured to type 0 fabric



1. CO$_2$ valve cable.
2. Weather shield.
3. Weather shield tiedown.
4. Patch for sheet lead.
5. Motor mount buckle straps.
6. Fabric loops for motor mount.
7. Rudder lock.
8. Socket to receive oar length.
9. Lifeline patch inboard.
10. Sleeve for mast insertion into keel.
11. Inflatable floor.
12. Valves for 2-compartment floor.
13. D-ring for bow mast stay.
14. Stowage pockets.
15. CO$_2$ hose assembly.
16. D-ring for starboard mast.
17. CO$_2$ cylinder and valve.
18. Sea anchor bridle.

Figure 3-12.—AR-4 lifeboat (basic plan).

patches by lengths of nylon webbing 1 inch wide, passed through the ring, and stitched to fabric patches. These rings, when installed, must be able to withstand a straight-away pull of at least 300 pounds.

MAST HALYARD CLEAT.—This is a metal cleat designed for attachment by clamping to the mast. It is used for securing the sail hoist and yardarm securing lines.

SAIL.—The sail material is made from 2-ounce sailcloth. Its color is blue, and the sail is equipped with a fabric sleeve to receive the yardarm.

RUDDER.—A collapsible wooden rudder folds in half, lengthwise, through the middle on hinges.

MOTOR.—No motor is supplied with the assembly; however, it is equipped to receive one of low horsepower.

MARKINGS ON THE RAFT.—When markings become obliterated, consult applicable publications for information that will direct the proper phrasing, size of the letters, paint or other liquid vechicle to use, and the location of the instructions to be reapplied.

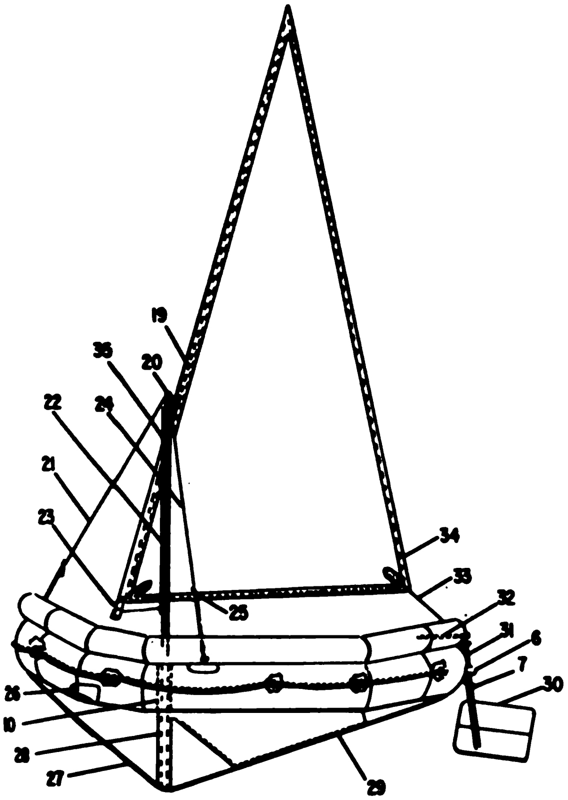
HAND PUMPS.—Two plastic hand air pumps are supplied for emergency inflation.

NYLON CORD.—One hundred feet of type I nylon cord is stowed in the supply pocket, and is intended for general utility purposes.

WHISTLE.—One police type whistle, equipped with a lanyard 3 feet long is provided.

BAILING SPONGE.—One sponge is provided.

EQUIPMENT CONTAINERS.—Two equipment containers are supplied with each boat. One is used to contain the following sailing equipment: Sail, mast, and yardarm sections; mast stay and halyard fittings; and rudder assembly. The other container holds all other items of equipment, except the sea anchor, instruction booklet, and bailing buckets. The contents are marked on the containers in 1/4-inch letters.



19. Yardarm sleeve in sail.
20. Mast stay and halyard fittings.
21. Bow mast stay.
22. Mast.
23. Yardarm.
24. Stay.
25. Stay adjustors, wooden.
26. Sea anchor D-ring.
27. Keel cable.
28. Fabric sleeve to receive mast.
29. Fabric keel.
30. Rudder, hinged through supports.
31. Rudder post.
32. Tiller.
33. Sail sheet lead.
34. Sail.
35. Halyard.

Figure 3-13.—AR-4 lifeboat (rigged for sailing.)

CARRYING CASE.—The boat is packed in the carrying case. The outer color of the case is orange yellow. The case consists of an outer ply of type II fabric (in accordance with specifications) backed up by a ply of 8-ounce cotton duck. The ends are closed by snap fasteners. The longitudinal opening is enclosed by a locking pin-and-cone assembly attached to the CO2 valve by a snaphook fasterner. This assembly is covered by a fabric flap, closed by snap fasteners. A pull on the valve cable releases the locking pins on the case before actuating the CO_2 valve. Two webbing straps are provided to suspend the unit from aircraft bomb racks. Each strap is made from webbing 2 inches wide (400-pound minimum breaking strength) equipped with a parachute harness V-ring on each end. Each strap is also equipped with buckles for adjustment. The maximum length of each strap assembly extended is 65 inches. A V-ring is installed at one end of the case at the base of the opening.

SEA ANCHOR.—One sea anchor is supplied with each raft, attached by a bowline knot to its mooring patch. The sea anchor must not be rolled inside the boat, but must be stowed in the boat carrying case, thus permitting the sea anchor to fall into the water upon inflation of the boat. When packing, care must be taken to insure that the bowline does not foul and bind the boat during inflation.

BAILING BUCKETS.—Two bailing buckets, constructed of type N fabric, 8 inches in diameter and 12 inches deep, are supplied with each boat.

JACKKNIFE.—One jackknife, equipped with a 3-foot lanyard is supplied with each boat.

ADDITIONAL EQUIPMENT.—Table 3-1 illustrates where the additional equipment is stowed in the AR-4 assembly; and also where the equipment previously described is stowed.

PACKING THE EQUIPMENT.—The bailing buckets are stowed in the port bow pocket. All rigid parts must be wrapped individually with cloth or felt paddings to protect the parts and the raft fabric from damage. The mast and oar sections must be secured together and be padded at both ends. The equipment containers are stowed adjacent to the CO_2 cylinder, one on each side of the cylinder, and each container is secured to the inside lifeline by a 6-foot length of type III nylon line.

The metal parts of the manifold and the CO_2 cylinder valve must be wrapped carefully with wads of cheesecloth or felt. The cylinder must also be padded at both ends. The CO_2 cylinder assembly is the heaviest single item of equipment for its size, and must be prevented from damaging the boat when the unit is dropped at or below 100 m.p.h. indicated airspeed.

All metal parts, such as D-rings, buckles, valves, etc., must be wrapped securely with cloth or felt padding.

Table 3-1.—AR-4 lifeboat equipment.

Article	Quantity	Furnished by	Installed by	Location
1. Anchor, sea	1	Contractor	Contractor .	Boat package.
2. Bag, water, stowage	4	. . . do. . . .	. . . do	Survival equipment containe
3. Booklet, instruction	1	. . . do. . . .	. . . do	Starboard bow pocket of boat
4. Bucket, bailing	2	. . . do. . . .	. . . do	Port bow pocket of boat.
5. Cleat, mast halyard	1	. . . do. . . .	. . . do	Sailing equipment container.
6. Compass, card type	1	. . . do. . . .	. . . do	Survival equipment containe
7. Container equipment. . . .	2	. . . do. . . .	. . . do	Boat package.
8. Fitting, stay and halyard	1	. . . do. . . .	. . . do	Sailing equipment container.
9. Kits, desalting	4	Government	. . . do	Survival equipment containe
10. Kits, repair	1	Contractor	. . . do	Starboard bow pocket of boat.
11. Jackknife	1	Government	. . . do	Survival equipment containe
12. Marker, dye pack	6	. . . do. . . .	. . . do	Do
13. Mirror, signaling	1	. . . do. . . .	. . . do	Do.
14. Paulin	1	Contractor	. . . do	Do.
15. Pump, hand.	2	. . . do. . . .	. . . do	Do.
16. Reflector, corner.	1	Government	Government	Do.
17. Rudder.	1	Contractor	Contractor	Sailing equipment container.
18. Sail.	1	. . . do. . . .	. . . do	Do.
19. Sections, oars, mast,	2 Sec. A.	. . . do. . . .	. . . do	Do.
yardarm.	6 Sec. B.	. . . do. . . .	. . . do	Do.
	2 Sec. C.	. . . do. . . .	. . . do	Do.
20. Signals, distress (day and night).	3	Government	. . . do	Survival equipment container.
21. Sponge, bailing	1	. . . do. . . .	. . . do	Do.
22. Stays, mast	3	Contractor	. . . do	Sailing equipment container.
23. Whistle	1	Government	. . . do	Survival equipment containe

The rudder is collapsed completely, bound together, and stowed well-padded, in the equipment container.

FOLDING THE LIFEBOAT.—First of all, the boat must be deflated completely. Then spread the boat flat so that gear may be stowed on it. Fold each side toward the middle and on top of all stowed gear. The CO_2 actuator control cable must fall on top of the starboard fold in a manner so that it can be operated after the boat is rolled.

Roll the boat from each end toward the CO_2 cylinder at the center. When rolling from the bow to the cylinder, care must be taken in order that the keel cable will not foul during the inflation of the boat. The cable is held as near as possible to the center of the bottom during the rolling operation. The keel must be extended flat on one side. The CO_2 actuating control must be kept clear.

The boat is placed in the carrying case, folded and rolled, with the open portion up, and aligned with the carrying case opening. This is to assure that the boat will float and inflate right side up on the water. After this, the case is closed as the releasing assembly is engaged.

The following inspections, as applicable, should be conducted on AR-4 lifeboats before they are placed in service, after receipt from stock, and semiannually thereafter:

1. Inflate boat with installed inflation system to ascertain that all parts of this equipment perform properly.

2. Inspect metal parts for evidence of corrosion, and examine body of boat, weather shield, spray tube, and inflatable floor for deterioration.

3. Remove the CO_2 cylinder from boat. Check manifold for leakage with soapy water.

4. Deflate boat, using a deflation or suction mp to insure complete removal of CO_2 gas.

5. Inflate one compartment of the boat with r to 2.0 p.s.i. Remove the cap from the pping-off valve in the deflated compartment. ter one hour, again check pressure and adst, if necessary, to the original pressure of 0 p.s.i. Note temperature. Allow compartent to remain inflated for 24 hours.

6. Conduct the same test on the other comrtment of the boat.

7. Test the spray tube in the same manner the one main tube compartment.

8. If the pressure of either compartment spray tube drops to less than 1.25 p.s.i. ter correction for temperature changes, conider the boat unfit for issue and check it further r leaks; if practicable, have it repaired.

9. Test each compartment of the inflatable oor as above with the exception that the initial ressure should be 1.0 p.s.i. with a drop to .5 p.s.i. permitted after 24 hours.

10. Deflate raft, using deflation or suction ump to insure complete removal of air.

11. Attach correctly charged cylinder (tolrance ± 1/2 ounce of total weight stenciled on ylinder) to raft and tighten all connections.

12. Check all sailing, signaling, and survival quipment for completeness, proper stowage ocation, and, where practicable, operation.

13. Examine raft case for oil and acid stains, nd for any visible defects or deteriorations likely to damage the contents of the case.

Where stowage space permits, the AR-4 assembly is carried in aircraft operating in cold weather regions. It is more suitably equipped for cold operations than the standard multiplace liferafts.

ADA-2 Arctic Survival Kit

The Arctic survival kit was designed to be dropped by parachute from multi-engine aircraft. Chest type parachutes are easily engaged with the rings of a webbing yoke which holds and centralizes the other three encircling straps. The straps are adjustable.

Figure 3-14 illustrates one application of a chest type parachute to the kit. Actually, any cargo type parachute of a suitable size (24 to 28 feet in diameter) could be used in rigging this kit.

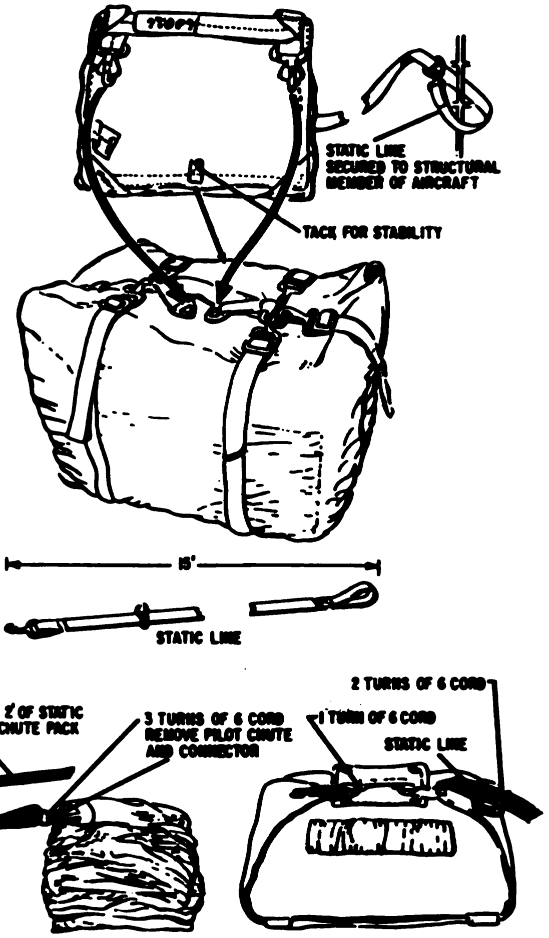

STATIC LINE SECURED TO STRUCTURAL MEMBER OF AIRCRAFT
TACK FOR STABILITY
15'
STATIC LINE
ENCLOSE 2' OF STATIC LINE IN CHUTE PACK
3 TURNS OF 6 CORD REMOVE PILOT CHUTE AND CONNECTOR
2 TURNS OF 6 CORD
1 TURN OF 6 CORD
STATIC LINE

Figure 3-14.—Rigging and dropping the ADA-2 kit.

The purpose of the kit is reflected in the items it contains. Any of the following items can be added or eliminated for substitution purposes in accordance with local requirements:

Antichap lipstick.
AN/PRC-17 transceiver.
C-3 rations.
Bag, sleeping.
Candles, 1 1/4 by 5 inches.
Cord, Nylon (Type 1), 50 feet.
Signal, Distress (Day and night) Mk 13 Mod 0.
Drawers, Men's wool, size 42.
File, 6-inch.
First aid kit, Aero.
Fishing equipment.
Flashlight.
Fuel, canned, Sterno, No. 4006 in 2 5/8 cans.

Mittens, Arctic.
Tablets, heating, fuel, Trioxane.
Stove assembly.
List of contents (ADA-2 kit).
M6 rifle/shotgun, 22 cal/410 and ammunition.
Survival kit (ax and saw).
Batteries, flashlight.
Brush, mountain.
Survival Manual, NA 00-80T-70.
Frying pan, 7 1/2 in. Dia.
Knife, survival, pilot's, with sheath.
Undershirts, wool, size 42.
Code, signaling.
Matches, box of waterproof.
Mosquito headnets.
Parkahood, detachable.
Paulin Mk 7.
Scarfs.
Signaling mirror.
Snare, self-locking, size 0, Raymond Thompson Co. or equiv.
Socks, wool, cushion sole, O. D. size 12.
Sun glasses (with case).
Tissue, facial, Kleenex or equiv. Std. size.
Whistle.
Wire, copper, soft or annealed—50 feet.

ADR-1 Ration Kit

This kit is designed to provide distressed personnel a maximum amount of water so they can maintain the pint-of-water-a-day considered the minimum requirement for survival. The size of the kit when packed is 21 x 8 x 6 inches. It can be carried and can be dropped from any type aircraft with suitable space. No special dropping technique is required to release the kit from aircraft as it is small enough to be thrown from a cockpit. When the kit is dropped, the aircraft should approach the area as slowly as possible (90 to 100 IAS—indicated air speed) and at about 100 feet altitude. The kit is buoyant and floats high in the water. In view of a commonsense approach, the kit should be dropped upwind of survivors. The kit can be secured to a parachute harness or other emergency gear by means of a lanyard and snaphooks provided. A list of the equipment follows:

4	Desalting kits
1	Water storage bag
1	Solar still
1	Jackknife
6	Ration tablet containers
	Length of cotton twine

AN/CRT-3A Radio Transmitter (Gibson Girl)

The AN/CRT-3A emergency radio transmitter is used to transmit distress signal and is carried in most multiengine aircraft. is also carried in all rescue aircraft and ca be dropped to survivors by means of a parachu attached to the container. The container hold the transmitter with the crank attached, on collapsible box kite, one signal light, two hydrogen generators, two transfer units, two balloons, and two spare antennas. The transmitter has range of up to 1,600 miles, depending on atmospheric conditions. (See fig. 3-15.)

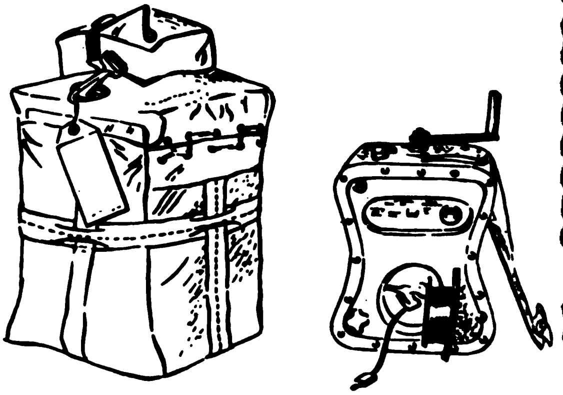


Figure 3-15.—AN/CRT-3A radio transmitter (Gibson Girl).

If at all possible, it should be dropped over water, for the possibility of damage to the transmitter is very great when dropped on land. When it is dropped by parachute, the static line should be secured to some part of the aircraft, the aircraft slowed down to its slowest safe speed, and the transmitter dropped at 300 to 500 feet. The direction of drift should also be taken into consideration when making the drop. If the transmitter is dropped to men in water, it should be dropped upwind; to men in a raft, downwind. In case more than one item is to be dropped, they should be tied together.

If the aircraft is ditched, the transmitter should not be tossed out until the aircraft comes a complete stop, for there may be more than e impact. When the aircraft has stopped, the ntainer should be thrown out an escape hatch. will float and can be picked up after other uipment has been removed and the raft has en boarded. If convenient, it should be tied to e raft.

There are two means of raising the antenna, kite or balloon. If there is enough wind, the te should be used; if there is no wind, then the lloon may be used. The antenna should never left up during a storm. There may be severe juries to personnel as a result of lightning riking and traveling down the antenna.

To set up the transmitter for operation on ater, remove the transmitter from the con- iner; then remove the ground wire, unroll it, d drop it into the water. Remove the cotter y from the face of the container, and the tenna compartment will open. With the com- rtment door fully open, place the cotter key the slot at the back of the door. This locks e door open. If the kite is being used, remove from the container and assemble. Estimate e speed of the wind and secure the antenna to e kite either at the point marked WINDS 7 TO 5 MILES PER HOUR or at the point marked INDS 15 to 40 MILES PER HOUR.

If the generator and balloon are being used, emove the top from the can containing the alloon. Insert the small end of the transfer nit into the neck of the balloon, making sure hat the transfer unit is inserted fully into the eck of the balloon. Take the key supplied with he generator and remove the end of the generator marked TOP. Screw the threaded end of the transfer unit into the threaded depression in the center of the generator. Remove the bottom of the generator with the key supplied and, holding the handle of the transfer unit, insert the generator into the water until the water is even with the top of the generator. It might be necessary to shake the generator slightly to get water into the carbide to begin action. Do not smoke while the balloon is being filled as hydrogen is explosive. It will take about 30 to 40 minutes to get all the gas from the generator. When the unit stops generating, remove the transfer unit from the generator and throw the generator away. The residue is caustic and will cause burns. Attach the antenna to the balloon and pay it out. Speed can be controlled by the brake on the drum. Turn the brake clockwise to tighten and counterclockwise to let the drum run free.

When the antenna is up, the operator should secure the transmitter by placing it between his legs, running the strap under his legs, and screwing it in the matching position on top.

The transmitter has a selector switch and three positions marked 8364 AND 500 KILOCYCLES, MANUAL, and LIGHT. By placing the selector switch at 8364-500 and turning the crank 80 to 100 r.p.m. an automatic SOS will be transmitted alternating 40 seconds on 8364 and 40 seconds on 500 kc. The probable daytime range of 8364 will be between 750 and 500 miles. The nighttime range may be increased greatly.

On 500 kc., when transmitting at sea under ideal conditions, the Gibson Girl has a range of 250 to 500 miles. Transmitting on land, the range may be reduced to as much as 5 to 10 miles.

By placing the selector switch at the manual position, a message or steady tone can be transmitted by using the key on the left side of transmitter.

When the generator light is on, it indicates that maximum voltage (24-31 v.) has been reached, and it will do more harm than good to crank any faster. By plugging a signal light in the transmitter and turning the selector switch to LIGHT, a steady light can be obtained or a blinker can be sent by using the key.

The international distress frequency is 500 kc., and international law requires that all ships and stations maintain silence and guard this frequency for two 3-minute periods during each hour, from 15 to 18 minutes past the hour and 45 to 48 minutes past the hour. These are excellent times for transmission.

If no lakes or rivers can be found to use as ground, a hole should be dug in the earth and the ground cable buried. Damp earth makes a good ground. The hole can be dampened by urinating in it and packing the earth around the ground cable. A good ground is important.

CAUTION: When the kit is dropped by parachute, the parachute static line should not be attached to any part of the body of the person dropping it.

Figures 3-16 and 3-17 illustrate the use of the transmitter.

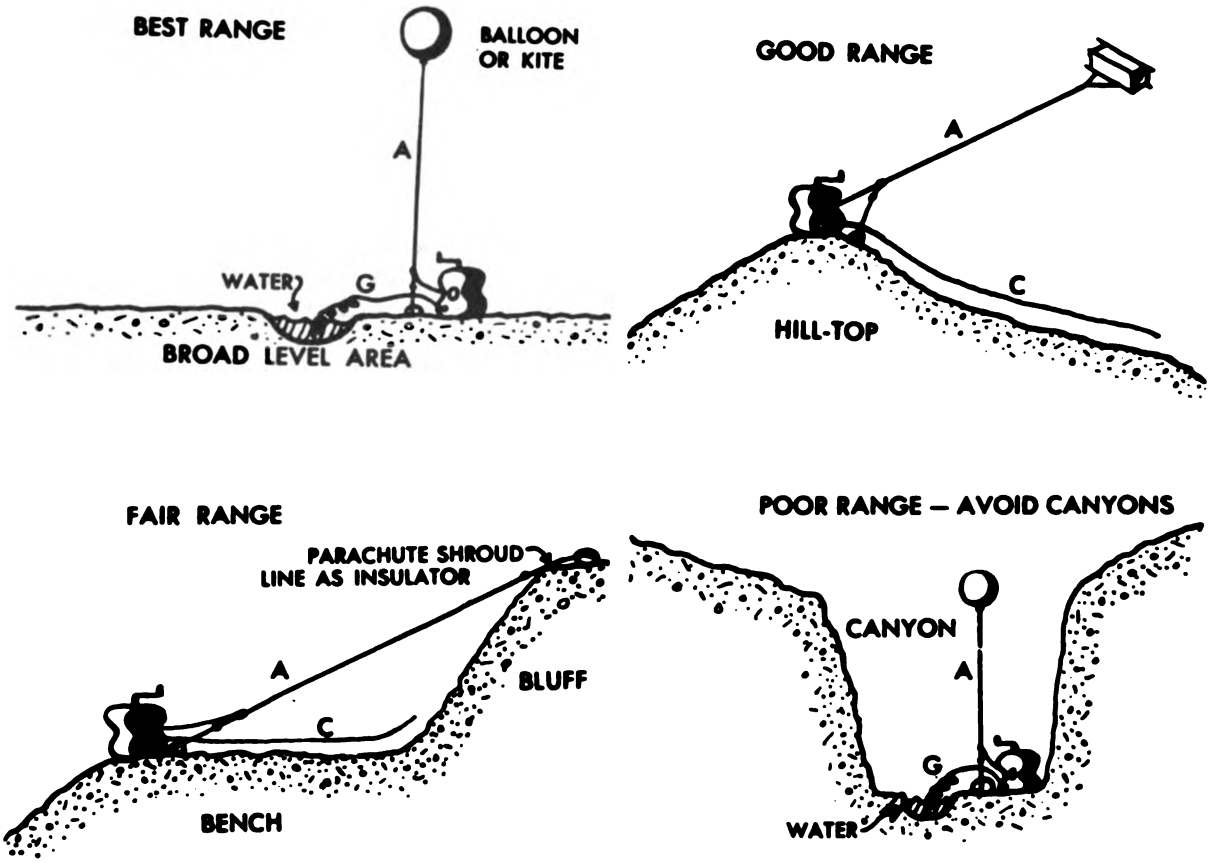


Figure 3-16.—Choice of terrain.

AN/PRC-17A Transceiver Beacon

The AN/PRC-17A is a personal, two-way voice radio plus beacon. It is stowed in the PK-2 pararaft kit. Total weight of the unit, including battery, is 7.5 pounds. The battery has a 12-15 hour operating life. Operating range is 10-20 miles with search aircraft at 5,000 feet. Compared with later equipment, the unit is large, heavy, and low powered.

AN/PRT-3 Radio Set

The AN/PRT-3 Transmitter Radio is a portable, automatically operated beacon operating on the guard frequency of 243.0 mc. It is actuated upon parachute deployment by means of the parachute riser pulling the lanyard for the switch plug as it unfolds from the parachute pack.

The pilot or plane captain is responsible for connecting the beacon lanyard to the D-ring prior to each flight and disconnecting it on completion of each flight.

This beacon transmits immediately following parachute opening and continues to transmit through the flexible antenna. After touchdown from bailout, the flexible antenna may be replaced by the telescopic antenna. This procedure is recommended whenever possible to give maximum range capability for searching aircraft.

Instructions for packing the AN/PRT-3 in various types of parachutes are contained in *Aviation Clothing and Survival Equipment Bulletins* 37-60, 38-60, 39-60, and 40-60.

AN/PRC-49 Radio Set

The AN/PRC-49 is a new air search personal radio transmitter with automatic beacon

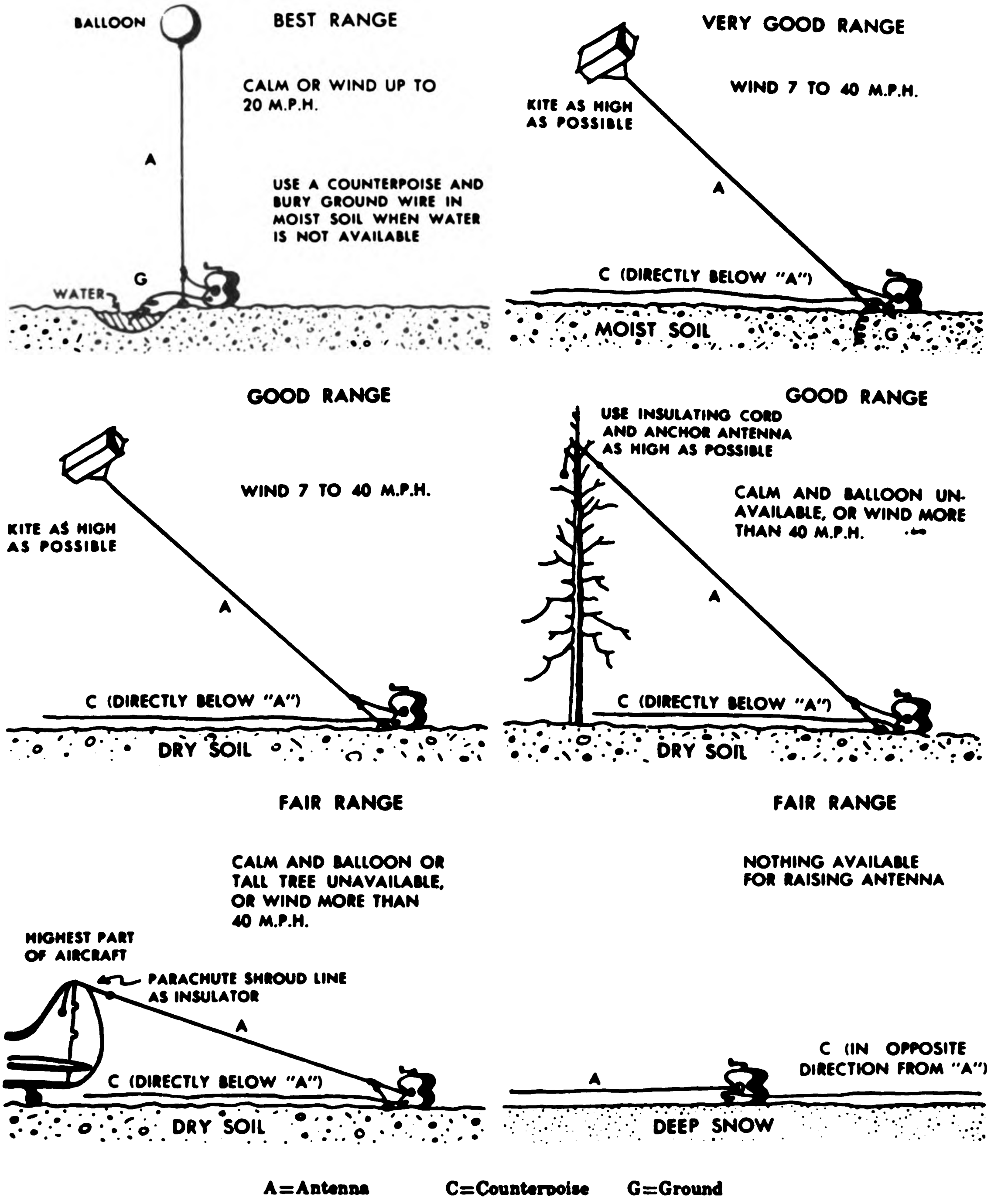

BEST RANGE
BALLOON
CALM OR WIND UP TO 20 M.P.H.
A
USE A COUNTERPOISE AND BURY GROUND WIRE IN MOIST SOIL WHEN WATER IS NOT AVAILABLE
G
WATER
VERY GOOD RANGE
KITE AS HIGH AS POSSIBLE
WIND 7 TO 40 M.P.H.
A
C (DIRECTLY BELOW "A")
MOIST SOIL
G
GOOD RANGE
KITE AS HIGH AS POSSIBLE
WIND 7 TO 40 M.P.H.
A
C (DIRECTLY BELOW "A")
DRY SOIL
GOOD RANGE
USE INSULATING CORD AND ANCHOR ANTENNA AS HIGH AS POSSIBLE
CALM AND BALLOON UNAVAILABLE, OR WIND MORE THAN 40 M.P.H.
A
C (DIRECTLY BELOW "A")
DRY SOIL
FAIR RANGE
CALM AND BALLOON OR TALL TREE UNAVAILABLE, OR WIND MORE THAN 40 M.P.H.
HIGHEST PART OF AIRCRAFT
PARACHUTE SHROUD LINE AS INSULATOR
A
C (DIRECTLY BELOW "A")
DRY SOIL
FAIR RANGE
NOTHING AVAILABLE FOR RAISING ANTENNA
C (IN OPPOSITE DIRECTION FROM "A")
A
DEEP SNOW
A=Antenna
C=Counterpoise
G=Ground

Figure 3-17.—Choice of setup.

capability. The unit recently completed design-approval tests and is now in service. A pilot-line quality is being procured for fleet use. The AN/PRC-49 may be carried in pararaft kits or mounted on lifevests and integrated harness assemblies.

The AN/PRC-49 consists of two units, the radio set and an external battery-size package. Combined weight of the two units is 3 pounds; battery life is 24 hours.

In addition to these basic units, an external antenna is provided for each installation to allow automatic beacon mode transmission. The radio set operates on three modes: transmit voice, receive voice, and transmit tone (beacon mode).

Normal installation requires that the unit be set in beacon mode with the external antenna connected. The power switch is set in the ON position, but power to the radio is shut off by means of the pull plug. The unit is then actuated by the pull plug in the power switch on parachute deployment or by any other desired means.

Once actuated, the unit will transmit during parachute descent and on the surface after landing without further attention. If the user desires, he may switch to the voice functions or make use of a telescopic antenna which is provided with the radio set.

The range of the unit varies with antenna configuration, 20 to 60 miles within line-of-sight distance.

AN/PRC-32 Transceiver

The AN/PRC-32 is a battery-powered, handheld, UHF transceiver. Its primary function is to provide two-way voice or keyed tone communication between distressed personnel and air or surface search craft, on an assigned frequency of 243.0 mc. The AN/PRC-32 can also be used for general-purpose short range communication.

It consists of a radio chassis with the necessary tubes, transistors, etc., housed in a lightweight aluminum case, and a battery, housed in a separate watertight case. The battery is connected to the AN/PRC-32 by means of a four-conductor cable and a waterproof connector located at the free end of the cable.

The AN/PRC-32 is simple to operate, bein so designed for emergency use by personnel who might be unfamiliar with radio communication. Operation is by means of three pushbuttons prominently located on the radio se housing. The function of each button is clearl indicated by read-outs stamped on the casing MCW KEY, PRESS TO TALK, ON-OFF. Instructions for operating the AN/PRC-32 are indelibl stamped on the back of the housing.

A three-section telescopic antenna is locate inside the AN/PRC-32 in a tubular housing The antenna should be fully extended when th unit is operated. The set is waterproof. Al joints and openings in the housing are seale against the entry of liquid. The antenna housing is considered part of the external case. A hole at the bottom of the antenna housing permits the draining of any moisture which may have penetrated the housing.

The AN/PRC-32 is connected to the antenna through a watertight insulated glass feedthru The mike-phone is sealed in the cover housin by means of rubber gaskets and is held in plac by a retainer ring. The transmitter sectio of the equipment consists of a crystal controlle oscillator and an RF doubler amplifier stage. The plate circuit of the oscillator also serve as a frequency doubler.

The receiver is of the superregenerativ type, and operates on the same frequency a the transmitter. Since the unit is designed for operation in the UHF region, communicatio should not be expected over anything but a limited distance over line-of-sight paths. A lock switch is provided on the housing of the radio set to prevent accidental energizing of the equipment. The lock switch locks the operating keys in either the operating or nonoperating position. The gross weight of the AN/PRC-32, including battery, is 4.5 pounds.

CHAPTER 4

SEWING MACHINE REPAIR

The Parachute Rigger is called upon to perform an enormous amount of repair work on parachutes and survival equipment in all types of maintenance activities. Although lower rated men perform much of this work, the task of maintaining the sewing machines in top running condition falls on the senior Parachute Riggers. Qualified machine operators may assist in this work under supervision; however, determining the causes of malfunctions, making major adjustments, and replacing of parts are the responsibility of the first class and chief.

CLASS 111 SEWING MACHINES

The most widely used sewing machine in the parachute loft is the Class 111 series. Machines in this class are designated as 111 W 151, 111 W 153, and 111 W 155. A brief description of each of these machines is included in this section, pointing out their differences and specific uses. Maintenance procedures presented in the following section are those recommended specifically for the 111 W 151 and the 111 W 155; however, in most cases they will apply to other models as well.

Sewing Machine 111 W 151

The Model 111 W 151 sewing machine is a single-needle, lockstitch, rotary hook textile machine, for high-speed straight seaming of medium-heavy materials. In parachute maintenance and repair, this machine is used primarily for general repair sewing.

The 111 W 151 sewing machine differs from other models of Class 111 in that it has a single presser foot instead of the alternating presser foot. Hence, the back of the machine arm casting for the 111 W 151 does not have the lifting rockshaft mechanism that is located above the knee lifter lever on other machines of this class. The 111 W 151 has a maximum speed of 3,500 stitches per minute.

The major assemblies for feeding material and stitching seams derive their power from the arm shaft, which is connected to the balance wheel. Proper operation, maintenance, and repair of the 111 W 151 sewing machine are based upon an understanding of the line of power and the interrelation of all components.

Timing Sequence for 111 W 151

The first step in timing the 111 W 151 is to set the feed driving eccentric on zero stitches per inch. Set the needle bar. With the needle bar in its lowest position (needle bar crank in the horizontal position, the rounded portion on the top and driving stud at the bottom), the connecting link will be vertical. Set the needle bar with the upper timing mark just visible at the base of the needle bar rock frame and tighten needle bar pinch screw. The needle bar is then properly set.

The next step is to time the arm shaft with the hook drive shaft. With the connection belt removed rotate the balance wheel toward the operator until the thread takeup lever is at its highest point, then align the arrow on the hook drive shaft timing plate, and replace the connection belt. Rotate the balance wheel and check. The next step is to center the feeding action. For this step the feed driving eccentric must be set on 0 spi. With the needle entering the feed dog, center the needle in the hold in the feed dog with a distance of 17/32 inch between the needle bar and the presser bar. In centering the feeding action the following is the sequence that must be followed: When the needle is properly centered in the feed dog, and the space between the needle bar and presser bar is right, tighten the feed driving crank pinch screw. Next, tighten the feed driving rockshaft crank pinch screw; making sure that the crank is flush with the end of the feed driving rockshaft crank pinch screw; making sure that the crank is flush with the end of the feed driving rockshaft and parallel with the bed. Next, tighten the needle bar rock frame rockshaft crank pinch screw in the back of the uprise. The shank of the presser foot may be used for measuring the space.

The next step is to set the sewing hook to or from the needle. This is done by moving the hook saddle left or right as necessary, the hook should pass the needle as close as possible without touching. When this is done, retighten hook saddle screws. Next, set the sewing hook with the needle. With the needle bar on the upstroke the lower timing mark on the needle bar should be just visible at the base of the needle bar rock frame. Set the point of the sewing hook in the center of the needle 1/16 inch above the eye. To advance the sewing hook, move the hook drive gear to the right; and to retard, move the hook drive gear to the left.

NOTE: The first screw in the pinion gear should be the spline screw and the second screw in the hook drive gear. The hook drive gear must be centered in relation to the sewing hook shaft at the bottom of the hook saddle.

Sewing Machine 111 W 153

The 111 W 153 sewing machine is designed for heavy work and is equipped with alternating presser feet for more positive feeding action. The positive feeding motion is brought about by the compound action of the alternating pressers. The rear presser holds the material down while the needle and forward presser are not in contact with the material; when the needle and forward presser come in contact with the material, the rear presser rises until the feeding motion of the needle, forward presser, and feed dog is completed.

This machine is not adaptable to light fabric work, as the feeding action of the alternating pressers puckers and damages lightweight fabrics. The maximum recommended speed of the 111 W 153 sewing machine is 2,900 stitches per minute.

Sewing Machine 111 W 155

The Model 111 W 155 sewing machine is equipped with a vertical-axis, rotating hook to carry the bobbin. No backstitching or darning can be done with this machine. The front or vibrating foot, the needle, and the feed dog move in unison. Together they move the cloth away from the operator with each completed stitch. The back presser foot, or vibrating presser, holds the fabric while the vibrating presser foot rises and moves forward.

The working space on this machine is 10 1/2 inches. The maximum operating speed is 3,500 stitches per minute. This machine can be regulated to sew from 3 1/2 to 32 stitches per inch. The proper needles to use for this machine are of class 135, variety 17, and the size of the needles run from 14 to 23. The motor used on the 111 W 155 sewing machine is a Singer electric transmitter, series S59. 210-230 volts, 1/3-horsepower, 60-cycle.

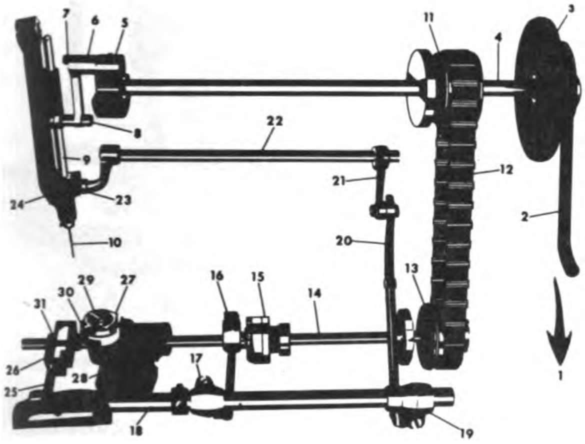
Maintenance and Repairs

Major sewing machine repairs consist primarily of replacing damaged or worn parts. The instructions given in this section cover the near complete disassembly of the 111 W 155 machine. However, since disassembly means complete resetting and retiming, the Parachute Rigger is cautioned not to strip the machine beyond those steps necessary for the replacement of the defective part. In stripping assemblies, be careful to note which screws are set into grooves in the various shafts since the machine cannot be retimed if setscrews are not properly positioned during reassembly. An understanding of the line of power shown in figure 4-1 will aid in performing necessary repairs.

INSPECTION AND CLEANING OF NEW EQUIPMENT.—If the equipment is crated when received, be careful to remove the crating, bracings, and packing material without damaging the parts. Watch for and save any special instructions, parts lists, tools, spare parts, and parts which may have shaken loose from the machine during shipment.

When a machine is received, and before it is installed or used, it must be thoroughly cleaned. All grease, grit, and corrosion preventives must be removed. Dry-cleaning solvent or diesel fuel oil may be used for cleaning. Small parts may be washed in the solvent; large parts should be sponged off with a rag dipped in the cleaning agent. Gasoline should not be used; the lead compounds in gasoline are poisonous and corrosive.

The installation of the machine received should be accomplished by following the instructions packed with each new sewing machine.



LINE OF POWER TO THE NEEDLE.

1. 1/3-hp. electric motor
2. Round leather belt/V belt.
3. Balance wheel.
4. Arm shaft.
5. Needle bar crank.
6. Needle bar driving stud
7. Needle bar connecting link.
8. Needle bar connecting stud.
9. Needle bar.
10. Needle.

LINE OF POWER TO THE NEEDLE BAR ROCK FRAME.

4. Arm shaft.
11. Arm shaft pulley.
12. Arm shaft connecting belt.
13. Safety clutch pulley.
14. Hook driving shaft.
15. Feed driving eccentric.
16. Feed driving connection.
17. Feed driving crank.
18. Feed driving rockshaft.
19. Feed driving rockshaft crank.
20. Needle bar rock frame rockshaft crank connection.
21. Needle bar rock frame rockshaft crank.
22. Needle bar rock frame rockshaft.
23. Needle bar rock frame slide block.
24. Needle bar rock frame.

LINE OF POWER TO THE FEED DOG.

4. Arm shaft.
11. Arm shaft pulley.
12. Arm shaft connecting belt.
13. Safety clutch pulley.
14. Hook driving shaft.
15. Feed driving eccentric.
16. Feed driving eccentric connection.
17. Feed driving crank.
18. Feed driving rockshaft.
25. Feed bar.
26. Feed dog.

LINE OF POWER TO THE SEWING HOOK.

4. Arm shaft.
11. Arm shaft pulley.
12. Arm shaft connecting belt.
13. Safety clutch pulley.
14. Hook driving shaft.
27. Hook driving gear. (Located under bobbin assembly; cannot be seen in the illustration.)
28. Hook driving pinion.
29. Sewing hook shaft. (Cannot be seen in illustration.)
30. Sewing hook.
31. Lifting cam. (Cannot be seen in illustration.)

Figure 4-1.—Line of power transmission.

Examine the nameplate on the motor to see whether the motor is made to operate on the current provided. Before belting the motor to the machine, lubricate and test it. When the motor switch is turned on, the motor should turn in a direction which will cause the balance wheel to turn towards the operator. If a motor turns in the wrong direction, the leads in the motor switch box should be disconnected and interchanged.

Before the machine is run with the motor, it should be tested by hand-turning the balance wheel to find out whether all parts of the machine operate freely and in correct time. If the balance wheel is hard to turn with no sewing material under the needle, further tests should be made to discover what part is binding.

ADJUSTMENTS AND REPAIRS.—If wear and damage cannot be corrected by proper adjustments, the Parachute Rigger will replace parts of the assemblies in accordance with current instructions. When new parts are installed, make certain that each new part is well lubricated and moves freely and without binding. A new part should never be forced or driven into place. The operation of a newly installed part should be tested by hand-turning the sewing machine. If the part binds, it may get hot and warp when the machine is put into operation. If a newly installed part fits too tightly, it should be dressed down carefully to make a snug fit. For dressing down iron or steel parts, emery cloth of a suitable grade may be used. However, emery cloth should not be used on brass or other soft metal bearings, because the abrasive material may become embedded in the metal and score the bearing surfaces of shafts.

STITCH REGULATOR.—The 111 W 155 sewing machine can be set to sew from 3 1/2 to 32 stitches per inch, as determined by the following operations:

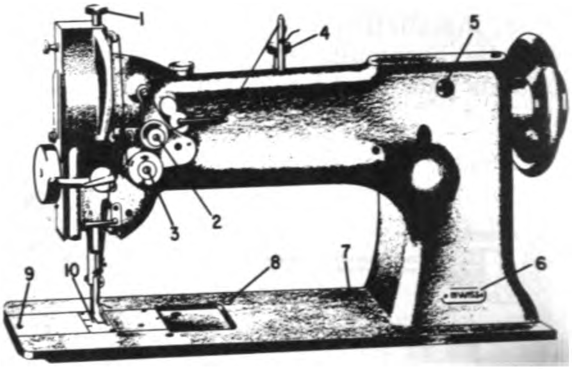
Hold down the plunger in the bed of the machine until you feel it drop into the slot in the feed driving eccentric cam. (See fig. 4-2.) Note that there are two plungers in the bed of the machine. For changing the length of the stitch, hold down the plunger closest to the needle bar. The other plunger is for use in re-engaging the safety clutch, as explained later. After you feel the plunger drop into the notch, hold it in the notch while rotating the balance wheel backward to shorten the stitch, or forward to lengthen the stitch.

The stitch indicator disc, which can be seen through the hole (5), normally turns with the balance wheel. The number seen through the hole while the plunger is pressed into the slot of the feed driving eccentric flange indicates the length of stitch for which the machine is set. To test the accuracy of the indicator, sew an inch, count the number of stitches being sewed to the inch, and compare the counted number with the number revealed through the stitch indicator hole.

NOTE: The stitch indicator disc does not control the number of stitches per inch, it only indicates how the feed driving eccentric is set. All feeding action originates and is controlled by the feed driving eccentric.

If the stitch indicator disc is not accurately set, it should be adjusted as follows:

With a pencil or tailor's crayon, make two parallel lines one inch apart on a scrap of fabric. Sew a line of stitches across both lines and at right angles to them. Count the stitches per inch and adjust the stitch regulator until the machine is sewing 8 stitches per inch.



1. Vibrating presser bar thumbscrew.
2. Tension thumb nut.
3. Thread controller stud thumb nut.
4. Presser bar spring regulating screw.
5. Stitch indicator disc view hole.
6. Model number.
7. Hook driving shaft lock ratchet plunger.
8. Feed regulating (plunger).
9. Bed slide.
10. Throat plate.

Figure 4-2.—Model 111 W 155 sewing machine.

Open the cover plate on top of the machine arm, and turn the balance wheel until the setscrew hole in the edge of the indicator disc comes into view. Run a screwdriver into this hole, as indicated in figure 4-3, and loosen the screw so that the indicator disc does not turn with the balance wheel.

Hold down the plunger and turn tne balance wheel until the plunger drops into the notch feed driving eccentric flange. Do not turn the balance wheel after the plunger engages the notch.

Without disturbing the balance wheel and with the plunger still engaging the notch, turn the stitch indicator dial until the figure "8" appears through the hole. Tighten the setscrew in the indicator disc. The machine will then be set to sew 8 stitches to the inch, and the indicator disc should indicate accurately.

THREAD TENSIONS.—The bobbin thread tension is regulated by the spring on the outside of the bobbin case. Do not take the bobbin case out of the hook assembly to change the tension. Use a small screwdriver to turn the setscrew in the center of the spring (near the thread slot in the bobbin case). To increase the tension, turn the setscrew to the right.

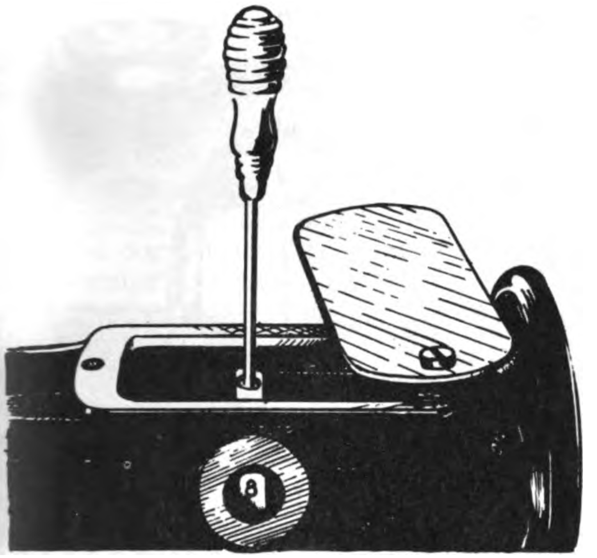
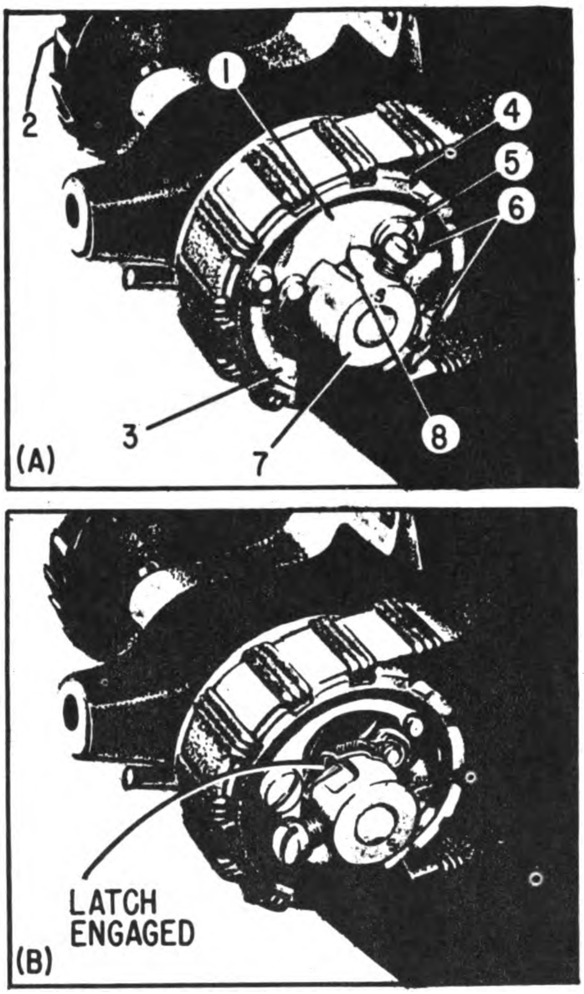


Figure 4-3.—Adjusting the stitch indicator.

The tension on the needle thread is controlled by the thumb nut in front of the tension discs. (See fig. 4-2.) To change the needle thread tension, lower the presser foot, causing the tension discs to close, and turn the thumb nut as necessary to put the correct tension on the thread. To increase the tension, turn the thumb nut to the right. Keep in mind that the tension on the needle thread can be regulated only when the presser foot is down.

SAFETY CLUTCH.—One setscrew in the hook driving pinion and one in the hook driving gear are splined. This splining of the screws is to prevent the gears and pinions from slipping around on their shafts and throwing the hook out of time with the needle. (See fig. 4-4 (A).) This also prevents damage to the machine when an unusual strain is thrown upon the hook or needle mechanism during operation. When an undue strain is thrown upon the machine, the safety clutch locking lever slips out of its notch and slides around on the collar. (See fig. 4-4 (B).)

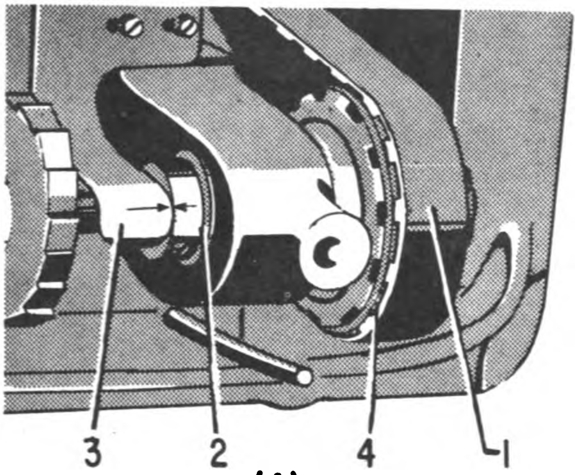
To re-engage the safety clutch after it has been operated automatically, press down the plunger nearest the uprise so that it engages in the lock ratchet on the hook driving shaft, and turn the balance wheel backward. The plunger will hold the hook driving shaft until the safety clutch locking lever turns around the collar and drops into the original notch. This operation will re-engage the clutch without disturbing the timing of the hook. Release the plunger, and turn the balance wheel forward to sew.



1. Safety clutch locking lever.
2. Hook driving shaft lock ratchet.
3. Safety clutch locking lever spring.
4. Safety clutch pulley.
5. Safety clutch locking lever hinge screw.
6. Safety clutch hook driving shaft. position collar setscrews.
7. Safety clutch hook driving shaft position collar.
8. Notch in the position collar.

Figure 4-4.—Safety clutch showing (A) locking lever in its operating position, and (B) throw-in latch in its operating position.

SETTING TIMING ARROWS.—When the thread takeup lever is at its highest point, the arrow stamped on the timing collar of the hook driving shaft will point to the arrow stamped on the timing plate attached to the underside of the bed. (See fig. 4-5(A).) When the machine is so set, the arm shaft and the hook driving shaft are properly timed.



(A)

1. Arm shaft connection belt.
2. Arrow on arm shaft connection belt timing collar.
3. Arrow on arm shaft connection belt timing plate.
4. Safety clutch pulley.

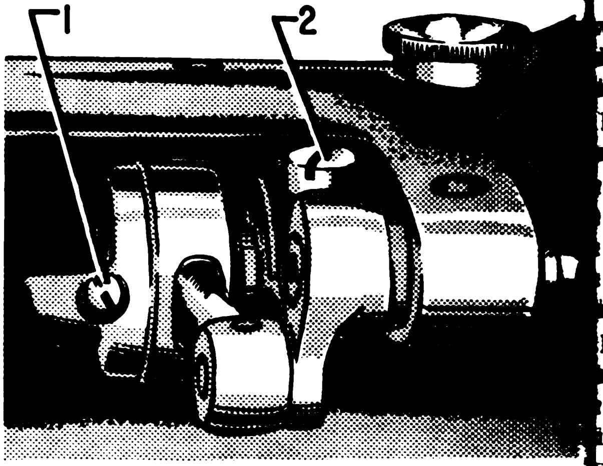
Figure 4-5 (A).—Timing arrows.

If the thread takeup lever is not at its highest point when the timing arrows are matched, the procedure for setting the machine is as follows:

Remove the arm shaft connection belt from the safety clutch pulley. Turn the balance wheel forward until the takeup lever reaches its highest point.

Rotate the safety clutch pulley with your fingers until the two arrows are matched. Keeping the takeup lever at its highest point and with the arrows matched, replace the arm shaft connection belt.

ADJUSTING RELATIVE HEIGHT OF LIFT OF VIBRATING AND LIFTING PRESSERS.—The amount of lift of the vibrating and lifting presser feet should be regulated according to the thickness of the material being sewed. The feet should lift just high enough to clear the material. As a rule, the vibrating and lifting pressers should lift an equal height, but some grades of work may require that they lift an unequal height. To change the relative lift o the presser feet, loosen the screw (2, fig. 4-5 (B)) at the back of the machine. Move th presser bar upward or downward as required, then securely tighten the screw.



(B)

1. Setscrew for the adjusting screw for adjusting the height of lift.
2. Setscrew for adjusting the relative height of alternating pressers.

Figure 4-5 (B).—Adjusting the relative heig and the height of lift of the vibrating and lifting pressers on machine 111 W 155.

ADJUSTING HEIGHT OF LIFT OF VIBRATING AND LIFTING PRESSERS.—When centering the feeding action on the 111 W 155 the distance between the presser bars should be 21/64 inch. The 111 W 155 has two adjustment points on the alternating pressers, which have a total height of 3/8 inch. To change the height of lift of the presser feet, loosen the setscrew (1, fig. 4-5 (B)) in the feed lifting eccentric. Turn the balance wheel forward until the adjusting screw is accessible. The adjusting screw is not visible in figure 4-5 (B), but will be located approximately in the same position as the setscrew when the balance wheel is turned forward. To increase the amount of lift, turn the adjusting screw counterclockwise. To decrease the amount of lift, turn the adjusting screw clockwise. Then turn the balance wheel forward and retighten the setscrew.

TIMING SEWING HOOK WITH NEEDLE.—With the needle bar on the upstroke (3/32 inch bove its lowest point), the point of the sewing ook must be in the center of the needle 1/16 inch above the eye of the needle.

If the needle bar does not have timing marks, turn the balance wheel forward until the needle ar has descended to its lowest position. Set he point of the needle even with the bottom of he feed dogs, rotate the balance wheel toward he operator until the needle bar has risen 3/32 nch, then set the sewing hook with the needle.

If the needle bar does have timing marks, rotate the balance wheel forward until the needle ar is at its lowest position. Set the needle bar vith the upper timing mark just visible at the ase of the needle bar rock frame. Rotate the alance wheel forward until the needle bar has isen 3/32 inch (the distance to the lower timing mark just visible at the base of the needle ar rock frame). Set the point of the sewing ook in the center of the needle 1/16 inch above he eye.

To test the correct timing of the needle, ee that the thread takeup lever is at its highest oint, that the timing arrows are matched, and hat the hook crosses the center of the needle /16 inch above the eye on the upstroke. If the est is not satisfactory, or if the sewing hook is ot picking up the thread, the machine should be imed in accordance with the procedures just iven.

To set the sewing hook with the needle, oosen the two screws in the hub of the hook riving gear (fig. 4-6). Be careful to keep the pot or spline screw in the slot cut into the riving shaft. Tap the hook driving gear along he shaft. If the hook is too slow, tap the gear o the right; if the hook is too fast, tap the gear o the left.

When the hook crosses the needle at a point /16 inch above the eye of the needle, securely ighten the two screws in the hub of the gear. e certain that the position screw is in the slot n the shaft. Make certain that the timing rrows mentioned are matched when the hook is orrectly timed.

RAISING AND LOWERING NEEDLE BAR.—efore attempting to raise or lower the needle ar, see that the needle is set correctly and as ar up in the needle clamp as it will go. Set he feed eccentric to indicate 0 stitches. Remove the faceplate, and take off the throat late so the needle and hook can be seen.

Loosen the needle bar connecting the stud pinch screw, and raise or lower the needle as required. When the needle rises 3/32 inch from its lowest position, the point of the hook should be crossing the center of the needle at a point 1/16 inch above the eye.

Procedure for setting the marked needle bar follows:

Needle bars which have been installed by the factory have 2 lines across the bar about 2 inches above the lower end. When the needle bar (fig. 4-7) is at its lowest position, the upper mark should be just visible at the end of the needle bar rock frame. If a marked needle bar must be raised or lowered, loosen the needle bar connecting stud pinch screw, and raise or lower the bar until the upper mark is just visible at the bottom of the needle bar rock frame when the bar is at its lowest position. Then retighten the screw.

If the hook is out of time after changing the height of the needle bar, follow the timing instructions previously given.

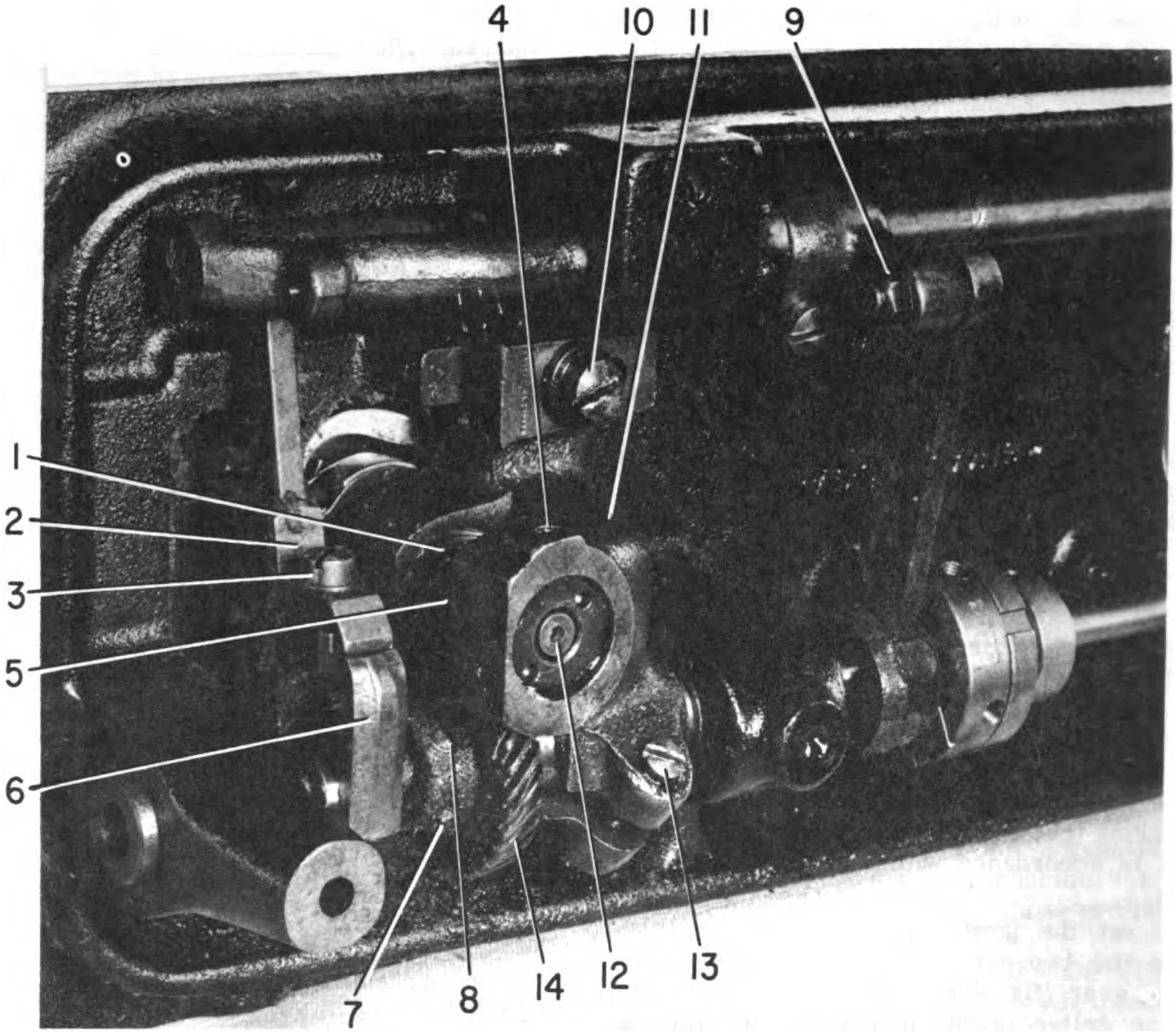
SETTING SEWING HOOK TO OR FROM NEEDLE.—The point of the hook should pass as close to the needle as possible without touching it. If the hook is too far from the needle, it will divide and cut the strands of the needle thread. If the point of the hook strikes the needle, it will be blunted or otherwise damaged.

The procedure for setting the hook to or from the needle follows:

Turn the balance wheel forward until the point of the hook stands opposite the center of the needle. (See fig. 4-8.) Loosen the two screws which hold the hook saddle. Tap the hook saddle to the right or left as required to bring the hook as close to the needle as possible without touching it. Retighten the screws.

The function of the hook guard washer (needle guard), which is attached to the bottom of the sewing hook is to prevent the point of the hook from striking the needle if the needle is deflected toward the hook when passing through the material.

The needle guard can be bent with a small pair of pliers until it prevents the hook point from striking the needle, but it should not be bent outward enough to deflect the needle from its normal path.



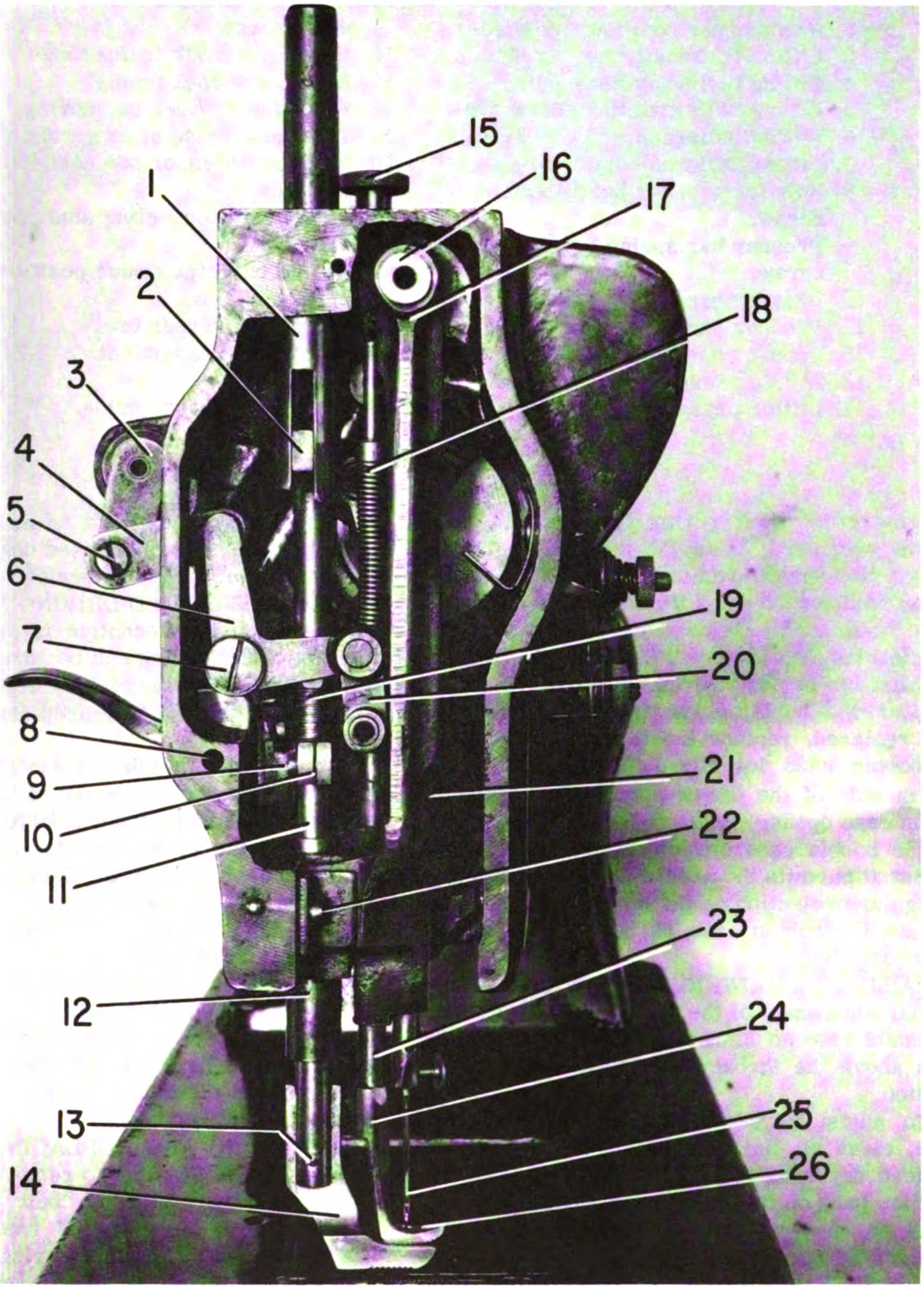
1. Hook driving pinion.
2. Feed bar.
3. Feed lifting cam fork screw.
4. Hook driving pinion setscrew.
5. Hook driving pinion position screw.
6. Feed lifting cam fork.
7. Hook driving gear pinion screw.
8. Hook driving gear setscrew.
9. Feed driving connection hinge screw nut.
10. Hook saddle screw.
11. Hook saddle complete.
12. Bottom of hook shaft.
13. Hook saddle pinch screw.
14. Hook driving gear.

Figure 4-6.—Hook saddle driving gear and driving pinion.

If setting the hook closer to the needle throws the hook out of time with the needle, retime the hook.

REMOVING, CLEANING, AND REPLACING BOBBIN CASE.—The bobbin case may be removed from the hook without taking the hook out of the machine. To remove the bobbin case, proceed as follows:

Remove the bed slide, throat plate, and feed dog to reveal the parts shown in figure 4-8. Remove the bobbin case opener by taking out the screw (4).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1. Presser bar position guide.
2. Presser bar position guide lever.
3. Lifting rockshaft.
4. Lifting bellcrank link.
5. Lifting bellcrank link screw stud.
6. Lifting bellcrank.
7. Lifting bellcrank cap screw.
8. Hole for presser bar lifter hinge screw.
9. Presser bar spring bracket pinch screw.
10. Presser bar spring bracket.
11. Presser bar, lifting.
12. Presser bar bushing.
13. Lifting presser bar foot screw.
14. Lifting presser bar foot.
15. Vibrating presser bar thumbscrew.
16. Needle bar rock frame hinge stud.
17. Needle bar rock frame.
18. Vibrating presser bar spring.
19. Tension release slide spring.
20. Vibrating presser bar connecting link.
21. Needle bar connecting stud pinch screw.
22. Needle bar rock frame position bracket screw.
23. Vibrating presser bar.
24. Vibrating presser foot.
25. Needle bar.
26. Needle bar thread guide.

Figure 4-7.—Face assemblies installed.

Remove the hook gib by removing the two screws which hold it to the body of the hook. The gib and screws removed from the machine appear in figure 4-9. Lift the bobbin case out of the hook body. Clean the bobbin case with dry-cleaning solvent or diesel fuel oil. Gasoline must not be used for this purpose.

After the bobbin case and hook gib have been replaced, replace the throat plate so that the bobbin case lug fits into the slot in the bottom side of the throat plate. Then replace bobbin case opener.

The bobbin case opener should be adjusted so that it permits the needle thread to pass the triangular projection on the bobbin case and then between the bobbin case lug and the bottom of the throat plate.

RAISING OR LOWERING FEED DOG.—The normal adjustment of the feed dog is as follows: It should rise no higher than the depth of the teeth above the throat plate when at its highest position.

To adjust the feed dog, remove the throat plate, clean all lint and dirt from the teeth of the feed dog, replace the throat plate, tip the machine back on its hinges, and turn the balance wheel forward until the feed dog rises to its highest position.

Loosen the feed lifting cam fork screw. Raise or lower the feed bar as necessary to make the feed dog stand the distance of a tooth above the throat plate when the dog is at its highest position. Tighten the feed lifting cam fork screw when the proper adjustment is accomplished.

When this adjustment is made, be careful that the underside of the feed dog does not drop low enough to strike the sewing hook.

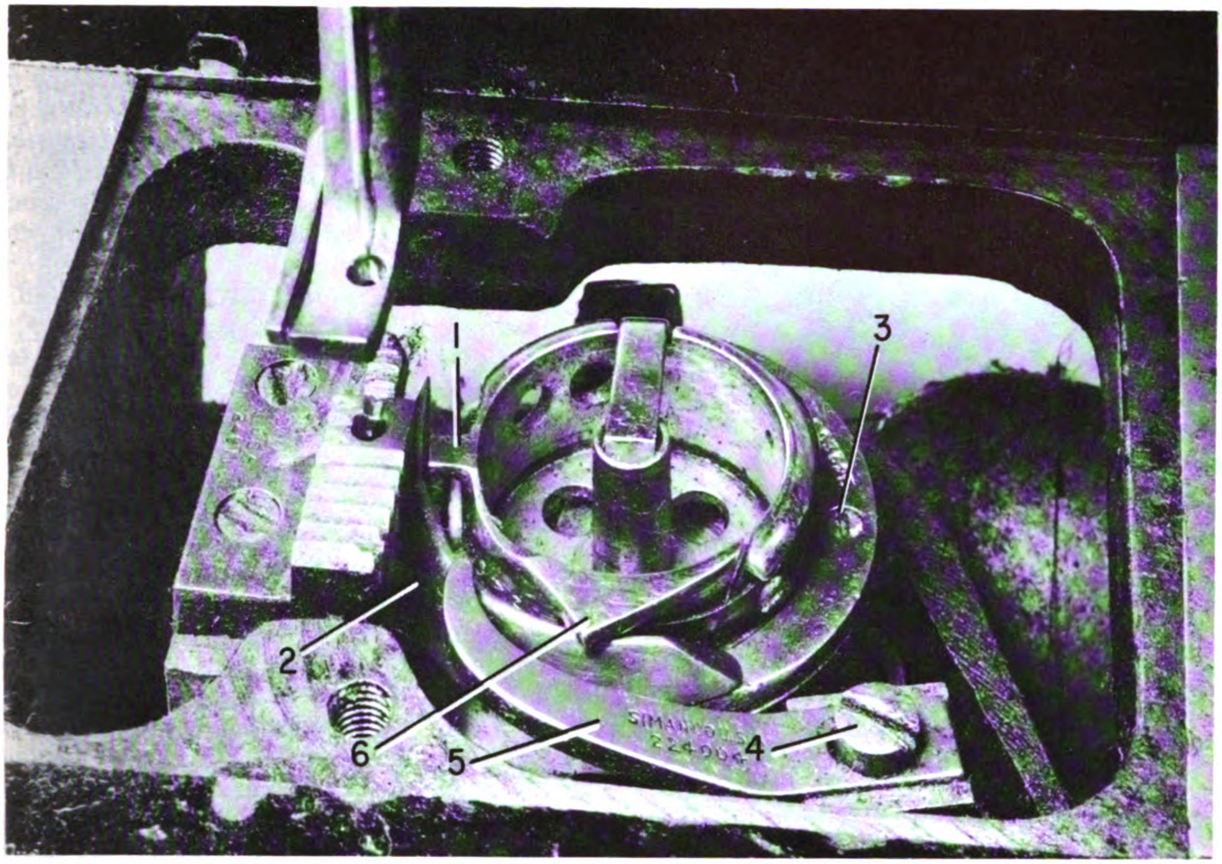
ADJUSTING FEED DRIVING ECCENTRIC.—The feed driving eccentric is provided with a gib (fig. 4-10), which can be adjusted to take up any wear or loose motion between the feed driving eccentric and the feed driving eccentric body.

To adjust the gib, loosen the two locking screws (8) near the ends of the gib. Then tighten the setscrews (7) until all play is eliminated and the eccentric fits snugly in the slot in the eccentric body or flange. Be certain to retighten the locking screws.

The adjusting spring (2) presses against the feed eccentric flange to prevent it from moving out of position. If the setscrews in the collar (1) are loosened, the collar may be moved to the right or left to change the pressure. The collar should be set so that the pressure of the spring holds the flange in firm contact with the feed eccentric body (6).

REMOVING AND REPLACING ARM SHAFT CONNECTION BELT.—To remove the arm shaft connection belt, slip the belt off the safety clutch pulley, remove the bearing setscrew (fig. 4-11), and slide the bearing from the arm casting. Remove the belt through the space normally occupied by the arm shaft bearing.

To replace the belt, work it through the space normally occupied by the arm shaft bushing and draw the belt down into the rise of the arm and over the arm shaft connection belt



1. Bobbin case lug.
2. Hook guard washer (needle guard).
3. Hook gib screws.
4. Bobbin case opener screw.
5. Bobbin case opener.
6. Bobbin case projection.

Figure 4-8.—Bobbin case installed in hook.

pulley. Replace the bearing with the oil hole up, and tighten the bushing setscrew. Replace the balance wheel, and tighten the balance wheel setscrew. Replace the balance wheel adjusting screw. Turn the balance wheel forward until the thread takeup lever is at its highest point and set the timing arrows as previously explained. Slip the connection belt over the safety clutch pulley.

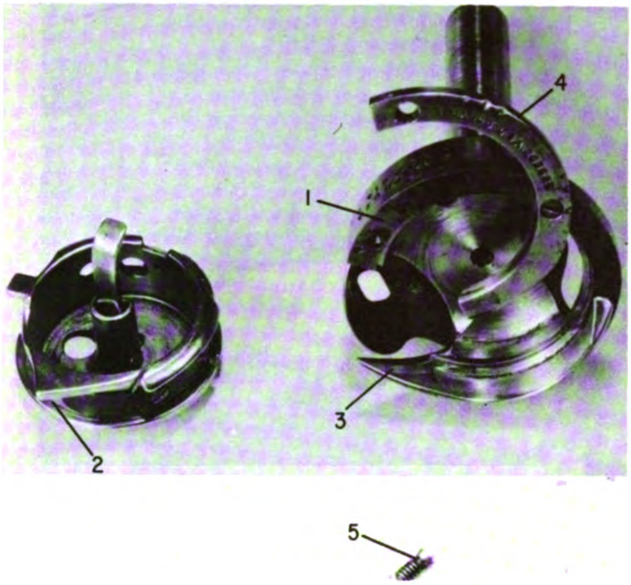
REMOVING AND ADJUSTING TENSION AND THREAD CONTROLLER.—The tension and thread controller is composed of two tension controlling components, one assembled on the tension stud and the other on the thread controller stud. (See fig. 4-12.) The spring and discs on the tension controller place tension on the thread when the presser foot is down. The spring in the thread controller pulls slack out of the thread between the time the thread takeup lever starts down and the needle point reaches the material.

The tension controller is adjusted with the thread controller stud. The spring stop is adjusted by loosening the screw and moving the stop to the right or left as necessary to stop the action of the spring as the needle enters the material. The amount of the tension will vary with the kind of thread being used.

SEWING MACHINE 31-15

Description

The 31-15 sewing machine, commonly referred to as a tailoring machine, is an oscillating type machine which makes a lockstitch. It is intended for sewing clothing, is excellent for nylon cloth sewing, and is used for sewing



1. Hook body only.
2. Bobbin case complete.
3. Point of hook.
4. Hook gib.
5. Hook gib screw.

Figure 4-9.—Hook removed from machine and disassembled.

lightweight canvas up to 8 ounces. This machine has a maximum speed of 2,200 stitches per minute. The length of stitches varies from 7 to 32 stitches per inch. The Singer Sewing Machine 31-15 is illustrated in figure 4-13.

Needles for the 31-15 machine are of class and variety 16 x 87. The needles are available in sizes from 14 to 23. The needles vary in size according to the number. The smaller the number, the smaller the needle diameter. Needles do not vary in length within the same class and variety.

Adjustments

TIMING NEEDLE WITH SHUTTLE.—When the needle and shuttle are correctly timed, the point of the shuttle on its forward stroke passes across the diameter of the needle at a point 1/16 inch above the eye of the needle when the needle is on its up stroke.

To time the machine so that the needle and shuttle operate properly (setting needle bar), proceed as follows:

See that the needle is of correct class and variety and that it is pushed up into the clamp as far as it will go. Remove the faceplate and loosen the screw in the needle bar connecting stud. Move the needle bar up or down as may be required to bring the needle eye into correct position when the shuttle point passes across the needle. Tighten the screw, and test the adjustment by observing the operation of the needle and shuttle while the balance wheel is slowly turned by hand.

TIMING FEED DOG WITH NEEDLE.—If the needle is correctly timed with the shuttle, the feed dog should be on its down stroke and level with the throat plate when the point of the needle reaches the material. If the balance wheel is turned forward, the needle should enter the material. If the balance wheel is turned forward, the needle should enter the material and come back up. After the needle has cleared the material on the upstroke, the feed dog should then rise above the throat plate and push the material forward the distance of one stitch.

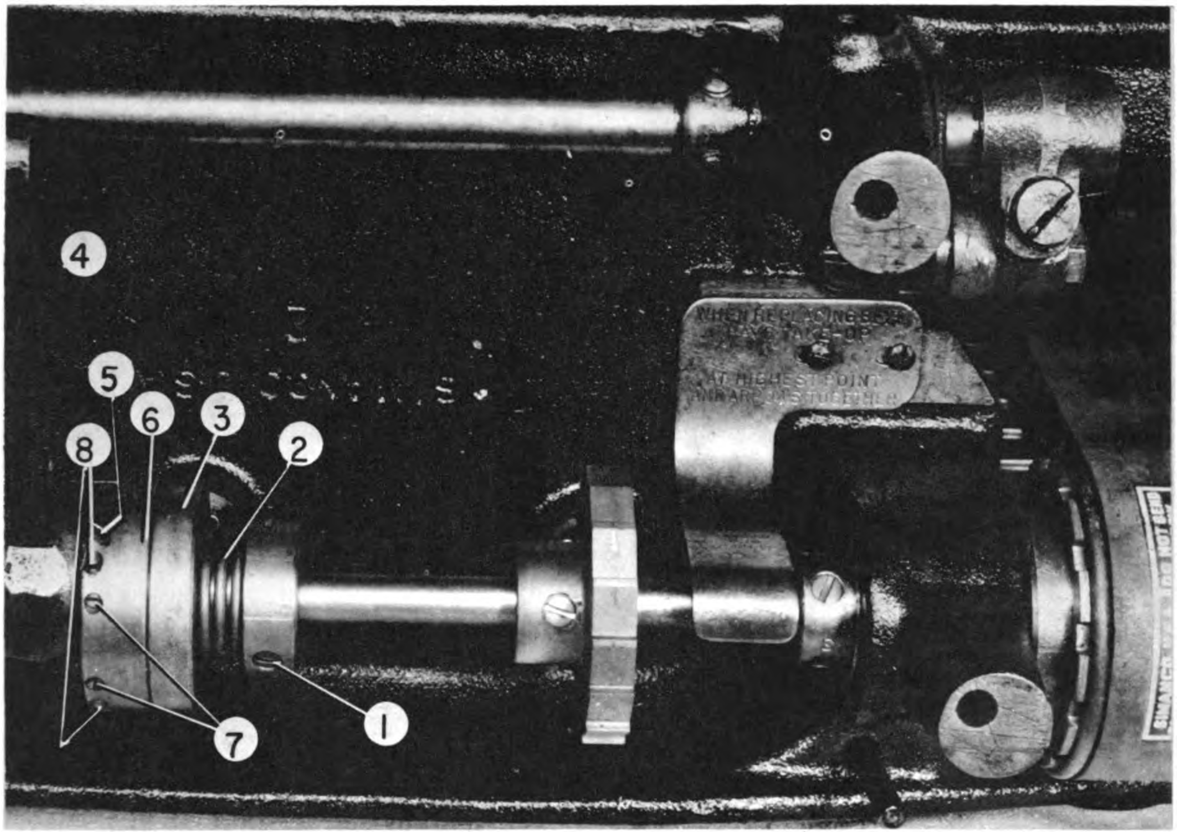
To time the feed dog (feed driving eccentric), proceed as follows:

See that the needle is correctly set and timed with the shuttle. Loosen and press the feed regulator thumbscrew to its lowest point. The machine will then make its longest stitch.

Open the round cover plate on the upright, as shown in figure 4-14. Loosen the feed eccentric setscrew. When the setscrew is loosened, the feed dog can be moved without moving the needle. By hand, turn the eccentric until the feed dog has completed its feeding action and is even with the throat plate on the down stroke. With the thread takeup lever at its highest point, retighten the feed eccentric setscrew. Test their timing after each adjustment of the feed dog.

RAISING AND LOWERING FEED DOG.—The feed dog is normally adjusted for sewing fabrics used in flight clothing, such as jackets, woolen shirts, and pants. When correctly adjusted, it rises just enough for the teeth to show their full length above the throat plate. For sewing extra heavy material (like that in overcoats) or for extra light material, the feed dog may need to be raised or lowered by adjusting the feed lifting rockshaft crank.

Before adjusting the height of the feed dog, see that it is in time with the needle. If the timing is correct, turn the balance wheel forward until the dog reaches its highest point. Loosen the screw on the crank, and adjust the



1. Feed driving eccentric flange spring collar.
2. Feed driving eccentric flange spring.
3. Feed driving eccentric flange.
4. Feed driving connection.
5. Feed driving eccentric friction gib.
6. Feed driving eccentric body.
7. Feed driving eccentric friction gib adjusting screws.
8. Feed driving eccentric friction gib adjusting screw setscrews.

Figure 4-10.—Feed driving eccentric assembly.

height of the feed dog up or down as desired. Tighten the screw and test the adjustment by hand-turning the balance wheel forward. A change in the height of the feed dog may throw the needle and feed dog out of time. Therefore, check and adjust the timing of the needle and feed dog as necessary.

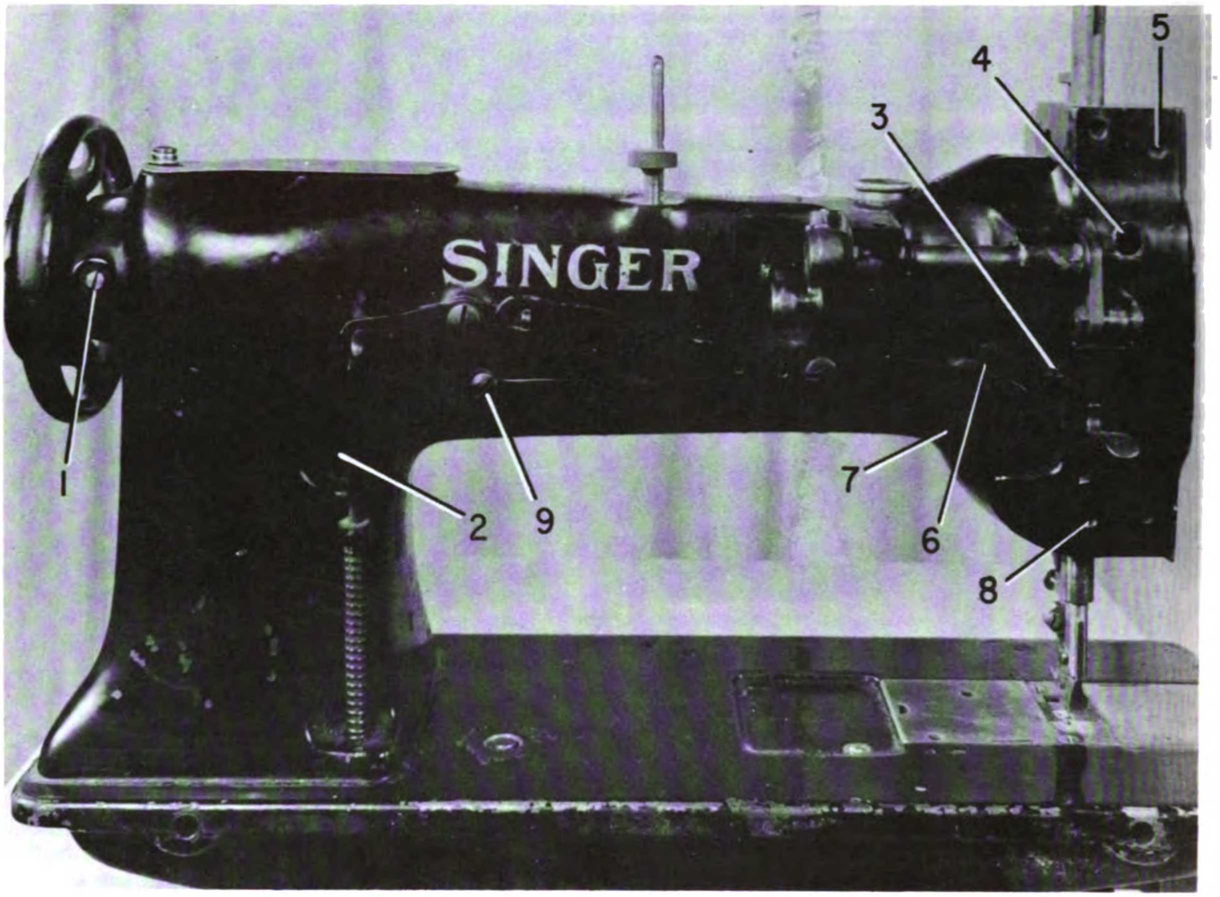
CLASS 7 SEWING MACHINES

The Singer Heavy-Duty Sewing Machine Models 7-31 and 7-33 are identical in performance.

Description

Class 7 sewing machines are all single-needle lockstitch machines designed for medium and heavy work on canvas, duck, or light leather materials. In parachute maintenance and repair, this machine is used primarily for the sewing of pack trays and webbing.

Model 7-33 sewing machine (fig. 4-15) utilizes a drop feed consisting of alternating presser feet and a feed dog to carry the material through the machine during sewing. The vibrating presser foot and the serrated lugs of



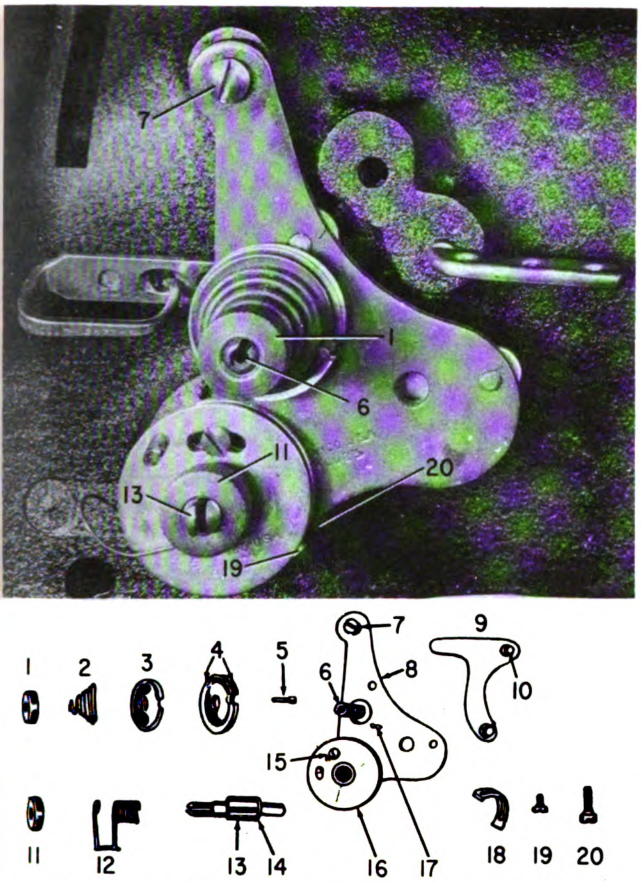
1. Arm shaft bearing setscrew.
2. Hole in back of arm for reaching the needle bar rock frame rock-shaft crank pinch screw.
3. Presser bar lifting bracket pinch screw for holding bracket.
4. Hole in back of face for reaching the presser bar position guide lever pinch screw.
5. Presser bar position guide setscrew.
6. Presser bar lifting releasing lever bracket guide screw.
7. Presser bar flat spring.
8. Presser bar bushing setscrew.
9. Presser bar spring support screw.

Figure 4-11.—Rear view of sewing machine head.

the double feed dog move in unison to push the material through the machine with each upstroke of the needle. The lifting presser foot then holds the material in place while the next stitch is being made and while the feed dog and vibrating presser foot move back into position for the next stroke.

Both the 7-31 and 7-33 machines use needles of class and variety 7 x 1 and 7 x 5; sizes available range from 19 to 31. The maximum recommended speed of both machines is 550 stitches per minute.

These heavy-duty machines employ a long-beak, oscillating cylinder shuttle which holds the bobbin vertically beneath the throat plate. With each rotation of the arm shaft, the shuttle rotates half a turn and back again. This rotation allows the hook to catch the needle thread, loop it around the bobbin, and thus form the stitch.



1. Tension thumb nut.
2. Tension spring.
3. Tension release washer.
4. Tension discs.
5. Tension release rod.
6. Tension stud.
7. Tension bracket screw.
8. Tension bracket.
9. Tension release lever.
10. Tension release lever screw.
11. Thread controller stud thumb nut.
12. Thread controller spring.
13. Thread controller stud.
14. Thread controller stud washer.
15. Thread controller disc screw.
16. Thread controller disc.
17. Tension disc position pin.
18. Thread controller spring stop.
19. Thread controller spring stop screw.
20. Thread controller stud setscrew.

Figure 4-12.—Tension and thread controller installed and disassembled.

Adjustments and Repairs

SETTING NEEDLE BAR.—To set the needle bar, remove the two screws holding the throat plate to the machine bed, and lift out the throat plate. Turn balance wheel forward until the point of the sewing hook is directly in line with the needle. Loosen the two setscrews in the needle bar connecting stud (fig. 4-16). Raise or lower the needle bar as necessary until the needle eye is 1/32 inch below the point of the hook. Tighten the two setscrews in the needle bar connecting stud.

A simplified method of setting the needle bar is to measure the height of the needle bar above the upper needle bar bushing of a machine that is properly set. This measurement may vary with the type of needle being used in the machine, but with 7 x 1 needles, the height of the bar above the bushing will be approximately 2 3/8 inches when the needle bar connecting stud is at its highest position.

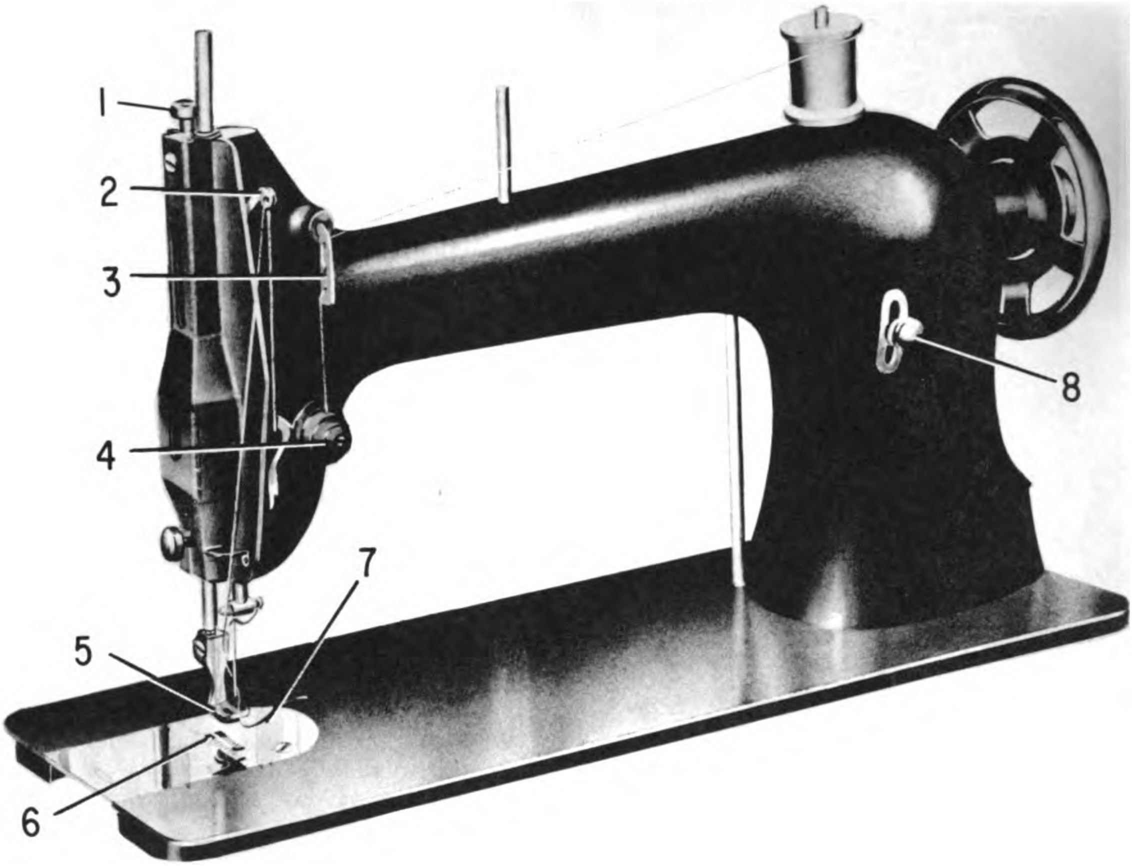
TIMING SEWING HOOK.—The timing of the sewing hook is permanently fixed by the construction of the shuttle assembly. Therefore, if the machine is correctly assembled, no adjustment for timing is required.

SETTING SEWING HOOK.—To set the sewing hook, loosen the shuttle race frame clamping screw and the two setscrews in the oscillating shaft collar beneath the machine bed. (See fig. 4-17.) Move the shuttle race frame (8) slightly to the left or right, as necessary, to bring the point of the hook as close to the needle as possible without touching the needle. Tighten the clamping screw securely and move the oscillating shaft collar up against the frame. Tighten the setscrews in the collar.

RAISE OR LOWER FEED DOG.—Loosen the lifting rockshaft crank clamping screw. Turn crank up or down on the feed lifting rockshaft to bring the feed dog to correct height. Tighten the clamping screw securely.

TIMING FEED DOG.—To time the feed dog, remove the arm side cover at the back of the machine. Loosen the two setscrews in the feed cam and set the cam for earlier or later movement of the feed dog, as required, by turning the cam about the arm shaft. (See fig. 4-18.)

Tighten the setscrews and test the feed dog timing by hand-turning the balance wheel. The feed dog should complete its feeding action at the same time that the thread takeup lever completes its upward stroke. When the feed dog is correctly timed, tighten the setscrews in the feed cam and replace the side cover.



1. Pressure regulating thumbscrew.
2. Thread takeup lever.
3. Thread retainer.
4. Tension regulating thumb nut.
5. Presser foot.
6. Feed dog.
7. Throat plate.
8. Feed regulator thumbscrew.

Figure 4-13.—Singer Sewing Machine 31-15.

SAFETY PRECAUTIONS

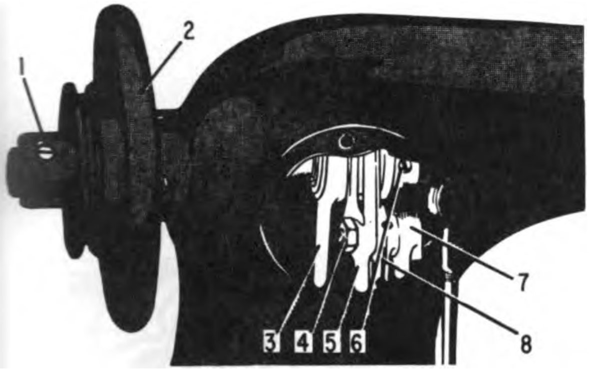
Before making any adjustments that may require contact with moving parts, cut off the motor or disconnect the drive belt. This is particularly important when changing needles. If the motor is not disconnected, stepping on the foot treadle will start the machine and may drive needles through the operator's hand or fingers.

While making electrical connections, be careful not to touch bare terminals or wires, since current required to run these sewing machines is usually of sufficient amperage to be dangerous

Be sure that the balance wheel always turns over toward the operator of the machine. Never turn the balance wheel more than a half turn back. Do not operate a machine without material beneath the presser foot. If it is necessary to test run a machine, remove needles. bobbins, and presser foot, or place a scrap of material beneath the presser foot. Keep the bed slide plates closed while machine is in operation.

SUPPLY

It is the responsibility of the Parachute Rigger in charge of the loft to make it his business to anticipate the loss and damage of certain small parts. All sewing machine parts listed in the supply catalog, with the exception of needles, must be ordered through the Supply Office, using an Open Purchase contract with the respective sewing machine manufacturers. This procedure takes time and



1. Balance wheel setscrew (2).
2. Balance wheel.
3. Feed lifting rockshaft crank connecting rod.
4. Feed regulator hinge screw nut.
5. Feed forked connection (connecting rod).
6. Feed and feed lifting eccentric setscrew.
7. Feed regulator.
8. Feed connecting link

Figure 4-14.—Connecting rods and feed eccentric.

s costly, but it is the only method to follow for he replacement or stocking of spare parts.

In order to accurately place an order for sewing machine parts, it is necessary to list he manufacturer, the manufacturer's part number for each item, the nomenclature, and the quantity required. It is also a good practice o mention the type or style of sewing machine for which the parts are intended, in case the manufacturer can substitute a part. This information will help the Supply Officer and will expedite the order.

Carefully follow the manufacturer's instructions for ordering parts. These instructions are found in the manufacturer's parts catalog. Every activity utilizing sewing machines should have a parts catalog for each type machine. Do not wait until something goes wrong before looking for a parts catalog.

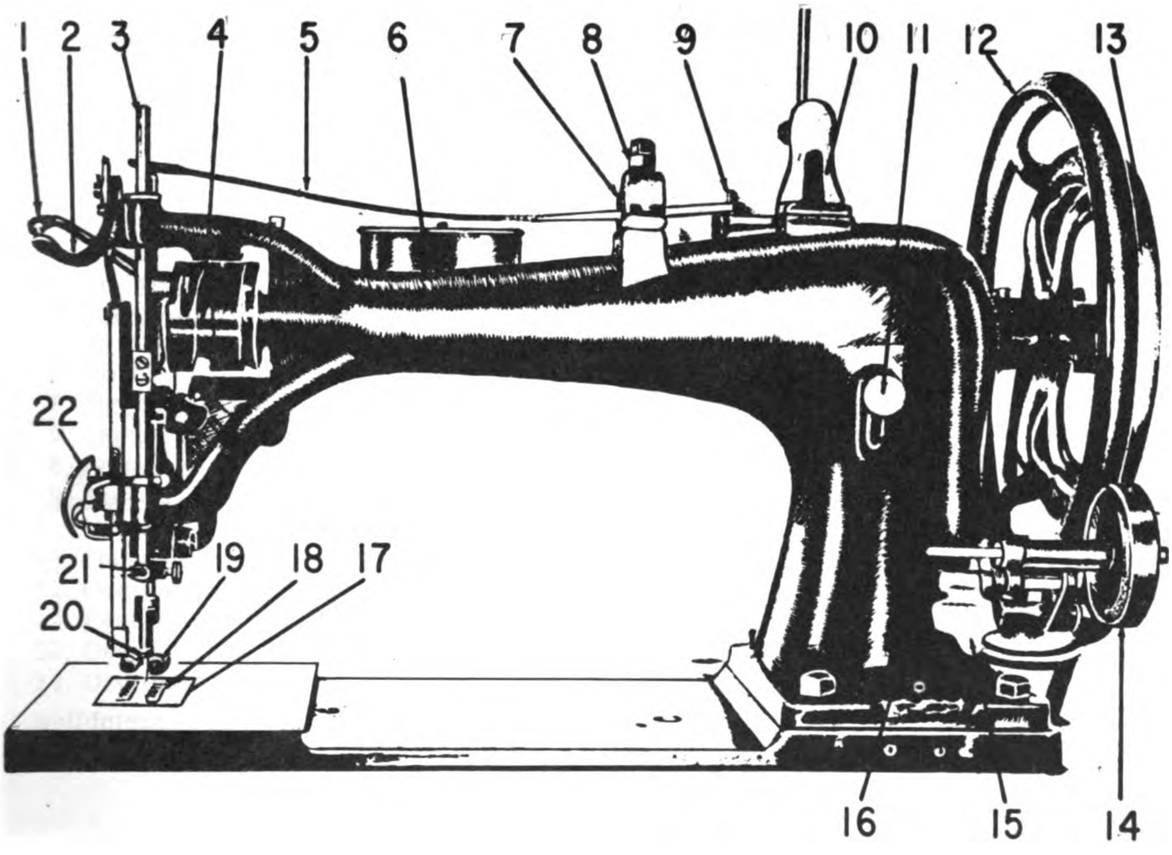
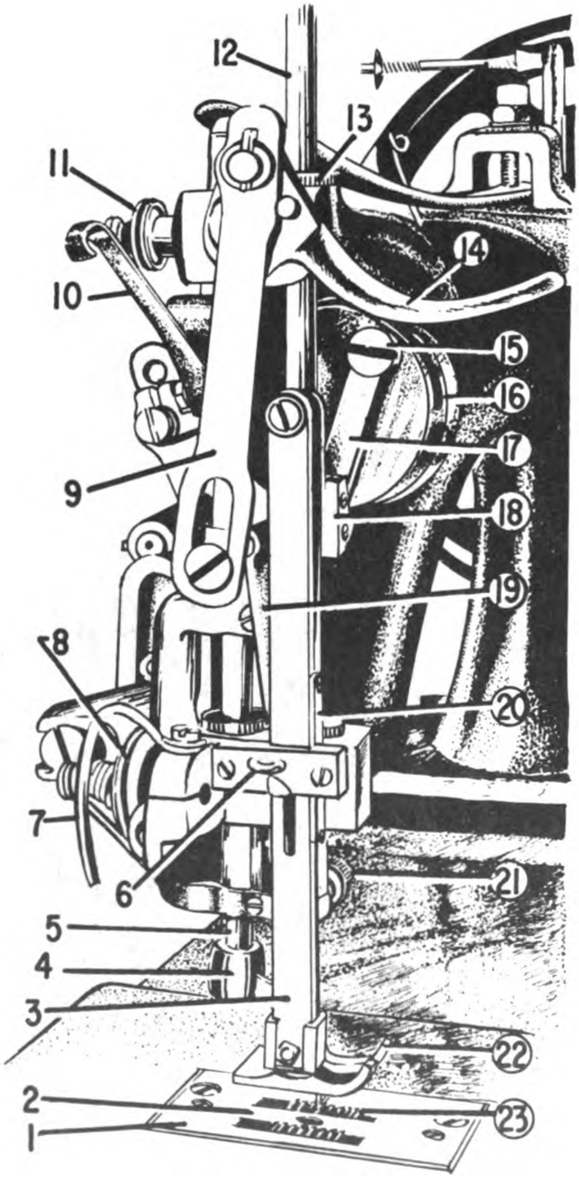


Figure 4-15.—Model 7-33 sewing machine.

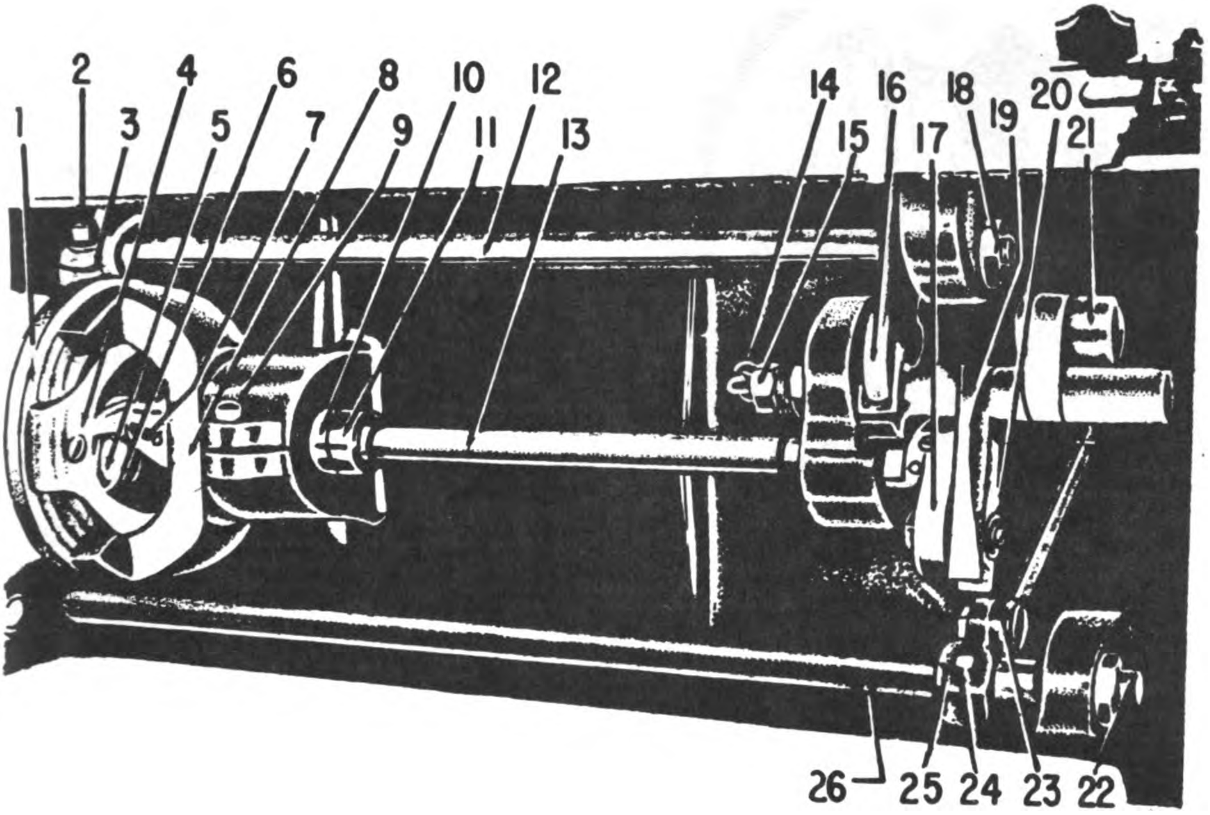
1. Thread takeup lever.
2. Lifting presser bar lifter.
3. Needle bar.
4. Thread takeup cam.
5. Vibrating presser bar spring.
6. Oil cup.
7. Vibrating presser bar spring adjusting staple.
8. Vibrating presser bar spring screw.
9. Vibrating presser bar spring stud.
10. Spool holder bracket.
11. Feed regulator thumbscrew.
12. Balance wheel.
13. V-belt.
14. Bobbin winder friction pulley.
15. Bobbin winder stop latch.
16. Bobbin winder spindle.
17. Throat plate.
18. Feed dog.
19. Vibrating presser foot.
20. Lifting presser foot.
21. Needle clamp.
22. Thread guide.

Figure 4-15.—Model 7-33 sewing machine.



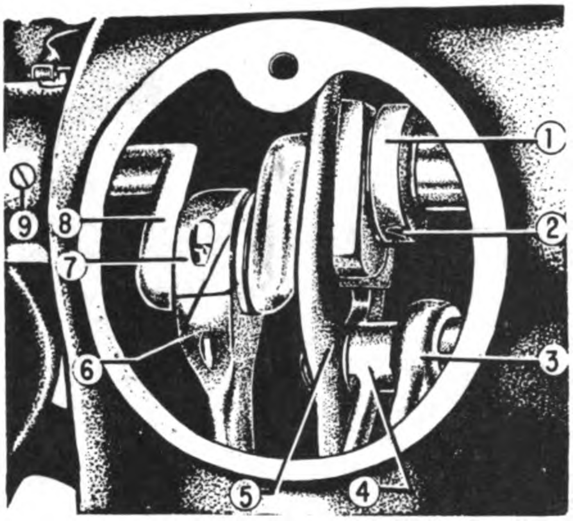
1. Throat plate.
2. Throat plate needle hole strip.
3. Vibrating presser bar.
4. Lifting presser foot.
5. Lifting presser bar.
6. Tension bracket with vibrating pressure bar cap.
7. Thread takeup spring staple.
8. Tension wheel.
9. Lifting presser bar lifting link.
10. Thread takeup lever.
11. Tension discs.
12. Needle bar.
13. Needle bar screw bushing.
14. Lifting presser bar lifter.
15. Needle bar connecting link hinge screw.
16. Thread takeup cam.
17. Needle bar connecting link.
18. Needle bar connecting stud.
19. Vibrating presser bar spring.
20. Vibrating presser bar cushion, rawhide.
21. Needle clamp thumbscrew.
22. Vibrating presser foot.
23. Feed dog.

Figure 4-16.—Face assemblies.



1. Shuttle race.
2. Feed lifting rockshaft crank clamping screw.
3. Feed lifting rockshaft crank.
4. Shuttle race back spring.
5. Bobbin.
6. Shuttle cylinder.
7. Shuttle driver.
8. Shuttle race frame.
9. Shuttle race frame clamping screw.
10. Shuttle race frame.
11. Oscillating shaft collar.
12. Feed lifting rockshaft.
13. Oscillating shaft.
14. Oscillating rockshaft oiling tube.
15. Oscillating rockshaft oiling tube point.
16. Feed lifting rockshaft.
17. Oscillating shaft crank.
18. Feed lifting rockshaft screw center and nut.
19. Oscillating rockshaft.
20. Oscillating shaft crank slide block.
21. Crank connecting rod.
22. Feed rockshaft screw center and nut.
23. Feed forked connection.
24. Feed rockshaft crank clamping screw.
25. Feed rockshaft crank.
26. Feed rockshaft.

Figure 4-17.—Bed assemblies.



1. Feed cam.
2. Feed cam setscrews.
3. Feed regulator.
4. Feed connecting link.
5. Feed forked connection.
6. Crank connecting rod.
7. Crank connecting rod cap screw.
8. Arm shaft.
9. Arm shaft bushing setscrew.

Figure 4-18.—Arm shaft assemblies.

Table 4-1.—Troubleshooting chart.

Trouble	Probable Cause	Remedy
Thread breakage.	Thread controller.	Adjust spring tension. Adjust spring stop.
	Right twist thread.	Change to left twist.
	Hook point piercing needle thread.	Set hook to needle.
	Needle eye too small.	Select larger size.
	Burr on needle point.	Remove burr.
	Hook out of time.	Retime.
	Too much tension.	Adjust tension springs.
	Improper threading sequence.	Rethread.
	Thread unwinding incorrectly.	Adjust stand and/or spool.
	Thread breaks when clearing work.	Adjust tension release. Thread takeup lever not at highest point.
Skipped stitches.	Hook too far from needle.	Move hook saddle.
	Hook out of time.	Retime.

Table 4-1.—Troubleshooting chart—Continued.

Trouble	Probable Cause	Remedy
Skipped stitches—Cont.	Needle bar improperly set.	Reset.
	Needle not all the way into bar.	Insert correctly.
	Needle incorrectly aligned.	Insert correctly.
	Thread too large for needle eye.	Select correct needle.
	Hook washer pushing needle.	Adjust washer.
	Thread controller spring out of adjustment.	Adjust tension and stop.
Thread jamming under throat plate.	Operating machine without material.	Unthread when running without material.
	Failure to hold free end of threads for first stitches.	Maintain pressure.
	Bobbin case opener incorrectly adjusted.	Readjust opener.
Thread bunching under material.	Failure to hold free end of threads for first stitches.	Maintain pressure.
	Needle thread not between tension disc.	Thread disc.
Thread jamming under bobbin case.	Turned balance wheel backwards when needle was threaded.	Remove jam.
	Thread, dirt, line under bobbin case.	Remove case, clean, replace.
Stitches not in line.	Insufficient presser foot pressure.	Add spring pressure.
	Feed dog too low.	Set height to one full tooth.
Not stitching as indicated.	Indicating disc loose.	Reset and tighten.

Table 4-1.—Troubleshooting chart—Continued.

Trouble	Probable Cause	Remedy
Not stitching as indicated—Cont.	Indicating disc incorrectly set.	Reset and tighten.
	Automatically changing stitches.	Adjust feed eccentric gib.
Noisy knee lifter.	Spring improperly adjusted.	Adjust while operating.
	Lifting rock lever rod too close to connection lever rod.	Adjust for operating.
Material damaged by scuffing.	Presser foot pressure too great.	Regulate pressure.
	Feed dog too high.	Set one full tooth or less.
Sluggish operation.	Improper oil or accumulation of foreign matter.	Clean with recommended solvent, dry and oil.
Feed failure.	Arm shaft not in time with sewing hook driving shaft.	Retime by takeup lever and timing collar plate.
	Lifting fork inverted.	Install properly.
	Feed crank pinch screw loose.	Center feed and tighten pinch screw.
	Feed eccentric out of spline.	Reset eccentric.
	Set at negative feed.	Set for stitching.
Failure to make stitch.	Machine out of time.	Inspection and retime.
	Needle threaded from wrong side.	Thread correctly.
	Hook too far away from needle.	Reset hook saddle.
	Wrong variety needle.	Change to correct length.
	Bent needle.	Change.

Table 4-1.—Troubleshooting chart—Continued.

Trouble	Probable Cause	Remedy
Failure to make stitch—Cont.	Needle not all the way into the needle bar.	Insert correctly.
	Safety clutch disengaged.	Clear jam. Re-engage clutch.
Binds.	Alternating pressers improperly set.	Reset to lift equally.
	Bobbin opener set too close.	Set to allow needle thread passage around bobbin case lug.
	Arm shaft friction washer missing.	Install friction washer.
	Balance wheel improperly set for end tolerance.	Tighten adjusting screw, back off 1/4 turn, tap screw with mallet.
	Needle bar too high or too low in frame.	Reset needle bar.
	Eccentric connection against eccentric body.	Set connection flush with cam.
	Hook guard washer rubbing opener lever link.	Replace washer. Adjust hook assembly for tolerance.
	Pinion gear against saddle.	Relocate on hook shaft.
	Driving gear against saddle.	Relocate to center on center line of hook shaft.
	Bobbin case thread jam.	Remove case, clear, reinstall.
	Feed dog against throat plate.	Adjust to proper height. Adjust to center of throat plate.
	Feed bar hinge stud screw.	Adjust for operating tolerance.

CHAPTER 5

MISCELLANEOUS NONPERSONNEL PARACHUTES

DECELERATION PARACHUTES

Deceleration parachutes are used for the purpose of shortening the landing roll during landings at shore bases when additional braking is required and for emergency on aborted takeoffs. In most installations, the deceleration parachute is deployed through an electrically actuated release mechanism and control circuit. Parachute Riggers are responsible for the maintenance, inspection, and repacking of the deceleration parachute. AE's are responsible for the electrically actuated release systems.

Figure 5-1 illustrates the components in a typical installation. Figure 5-2 shows the general construction of the pilot chute and main canopy.

In this installation, the parachute is deployed electrically. When the circuit is energized to deploy the parchute, the release mechanism engages the riser link, then unlatches the container doors which are spring loaded.

As the doors open, the parachute assembly falls from the container, the ripcord securing the pilot chute on the deployment bag is withdrawn, and the ejection spring deploys the pilot chute. The resulting drag pulls the deployment bag from the container, disengaging the deployment bag locking webbing, and opening the bag. Continuing drag of the pilot chute deploys the main canopy which then extends the suspension lines and the riser. The deployment bag remains secured to the riser by the deployment bag bridle.

Jettisoning of the deceleration parachute at the end of the landing roll is also accomplished by the electromechanical release mechanism. When the control circuit is energized to jettison the parachute, the release mechanism is actuated, disengaging the riser link, thus releasing the parachute from the aircraft.

Two emergency provisions for jettisoning the parachute are also incorporated in the system. If the control circuit is energized, deploying the parachute at airspeeds above 175 knots, the shear pin connecting the riser link to the parachute will fail, jettisoning the parachute. If the container doors should open without electrical actuation of the release mechanism, a shear rivet in the latch mechanism will fail, jettisoning the parachute.

DECELERATION PARACHUTE MAINTENANCE

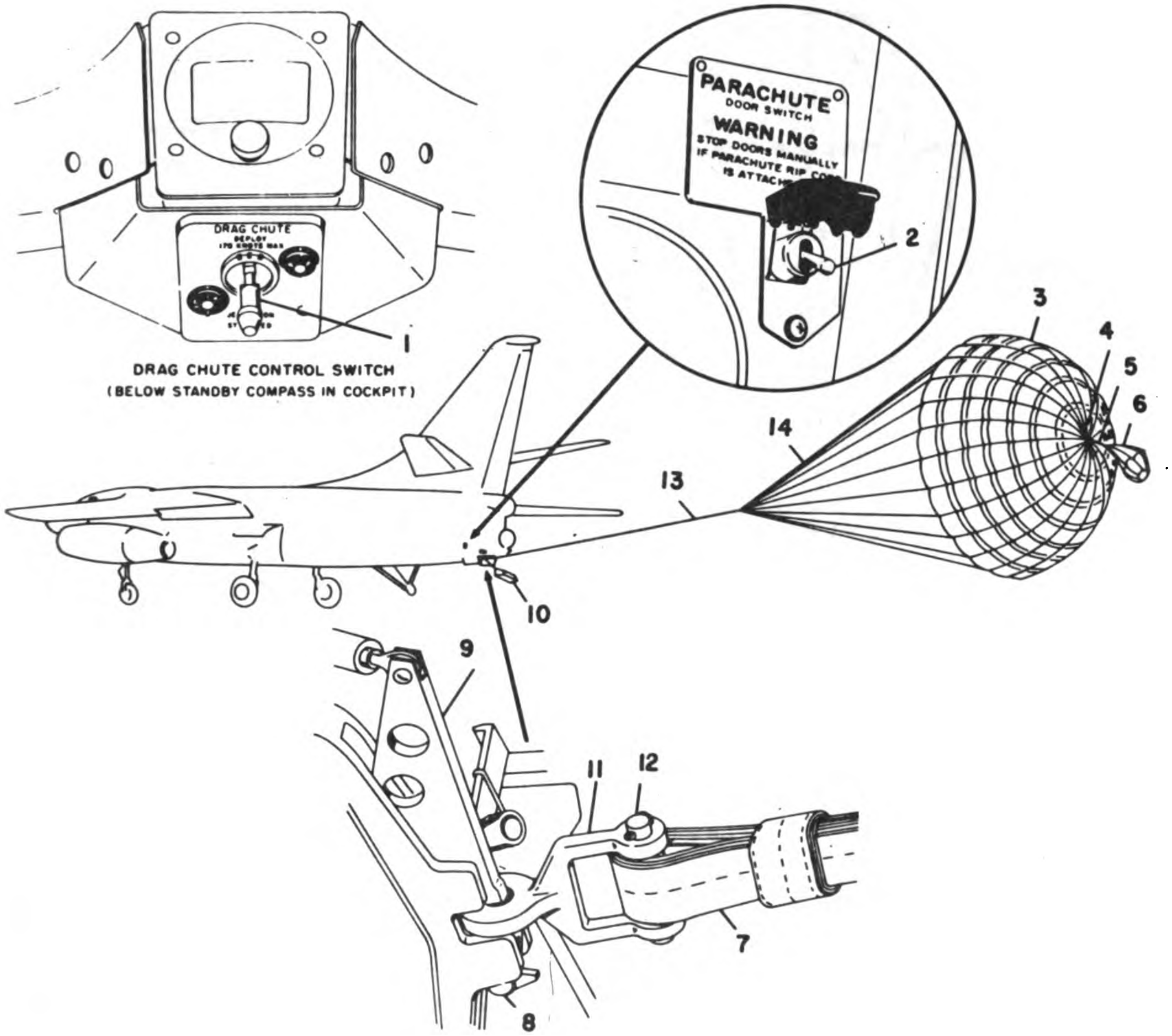
Instructions for packing, inspecting, repairing, installing, and removing deceleration parachutes are provided in the Maintenance Instructions Manual for each naval aircraft so equipped. The following instructions apply to the A3D series aircraft and are taken from NavWeps 01-40ATA-2-13.

Packing (A3D Series Aircraft)

STRAIGHTENING PARACHUTE.—Turn the canopy right side out with the pocket bands on the outside of the skirt, as shown in figure 5-3. Extend the parachute to full length, locating suspension lines 1 and 28 in the uppermost position.

Hold suspension lines 1 and 28 at the skirt and follow the main seams of lines to the vent, straightening the canopy and placing the seams in the uppermost position. Separate the vent lines into two equal groups, lines 1 through 14 forming one group and the remaining lines forming the second group.

EQUALIZING VENT LINES.—Attach a tension device to the vent lines through the separation in the vent lines made by the centering loop. Do not attach the device to the centering loop. Place the fingers of the right hand between the vent lines on the right side of the centering loop and the fingers of the left hand between the vent lines on the left side of the centering loop. Work the vent lines back and forth by pulling on the upper lateral band until the vent is even on both sides. (See fig. 5-3.)



1. Control switch.
2. Door switch.
3. Main canopy.
4. Vent lines.
5. Pilot chute bridle.
6. Pilot chute.
7. Riser loop.
8. Riser link latch.
9. Riser link hook.
10. Deployment bag.
11. Riser link.
12. Shear pin.
13. Riser.
14. Suspension lines.

Figure 5-1.—Typical deceleration parachute installation.

ATTACHING PILOT PARACHUTE BRIDLE.—Pass the small loop end of the bridle hrough the vent lines at the separation formed by the vent lines centering webbing. Form a half hitch by passing the opposite end of the bridle through the small loop in the bridle and tighten the half hitch. (See fig. 5-4.)

ATTACHING PILOT CHUTE.—Insert the free loop end of the bridle through the attaching loop at the bottom of the pilot parachute vanes. Spread the large loop in the bridle, pass the entire pilot parachute through the loop and then tighten the half hitch formed by the bridle loop and pilot parachute attaching loop. (See fig. 5-4.)

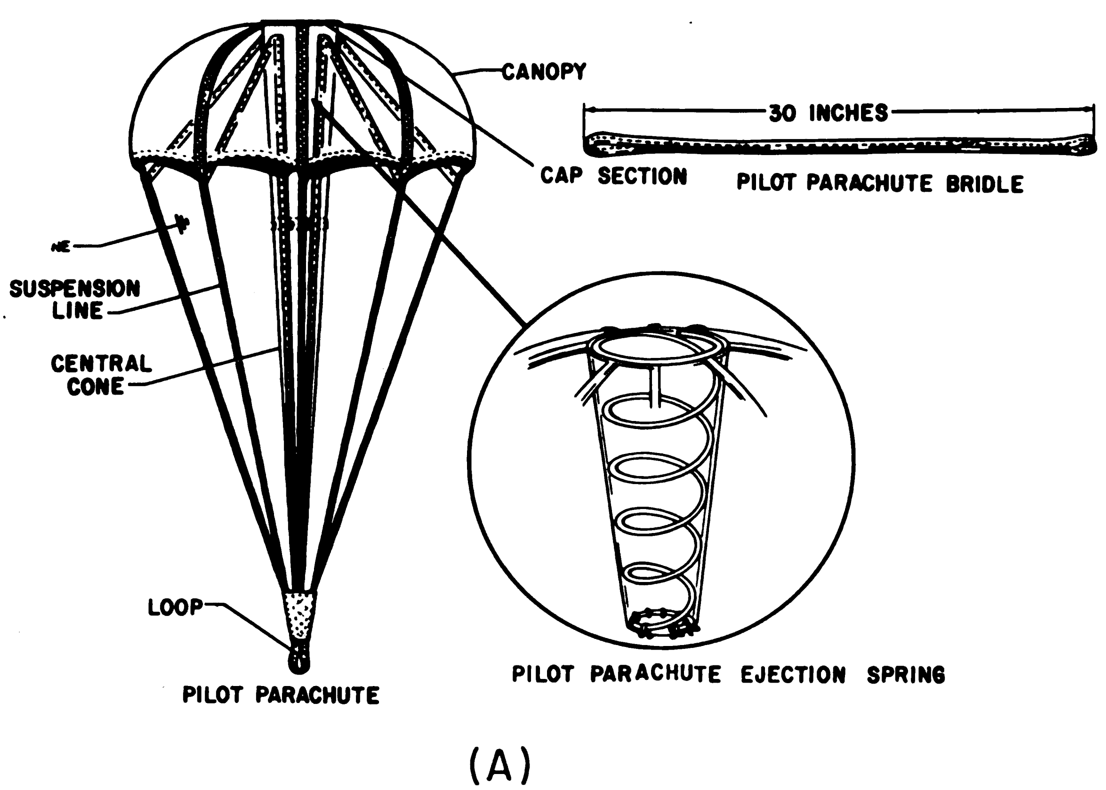


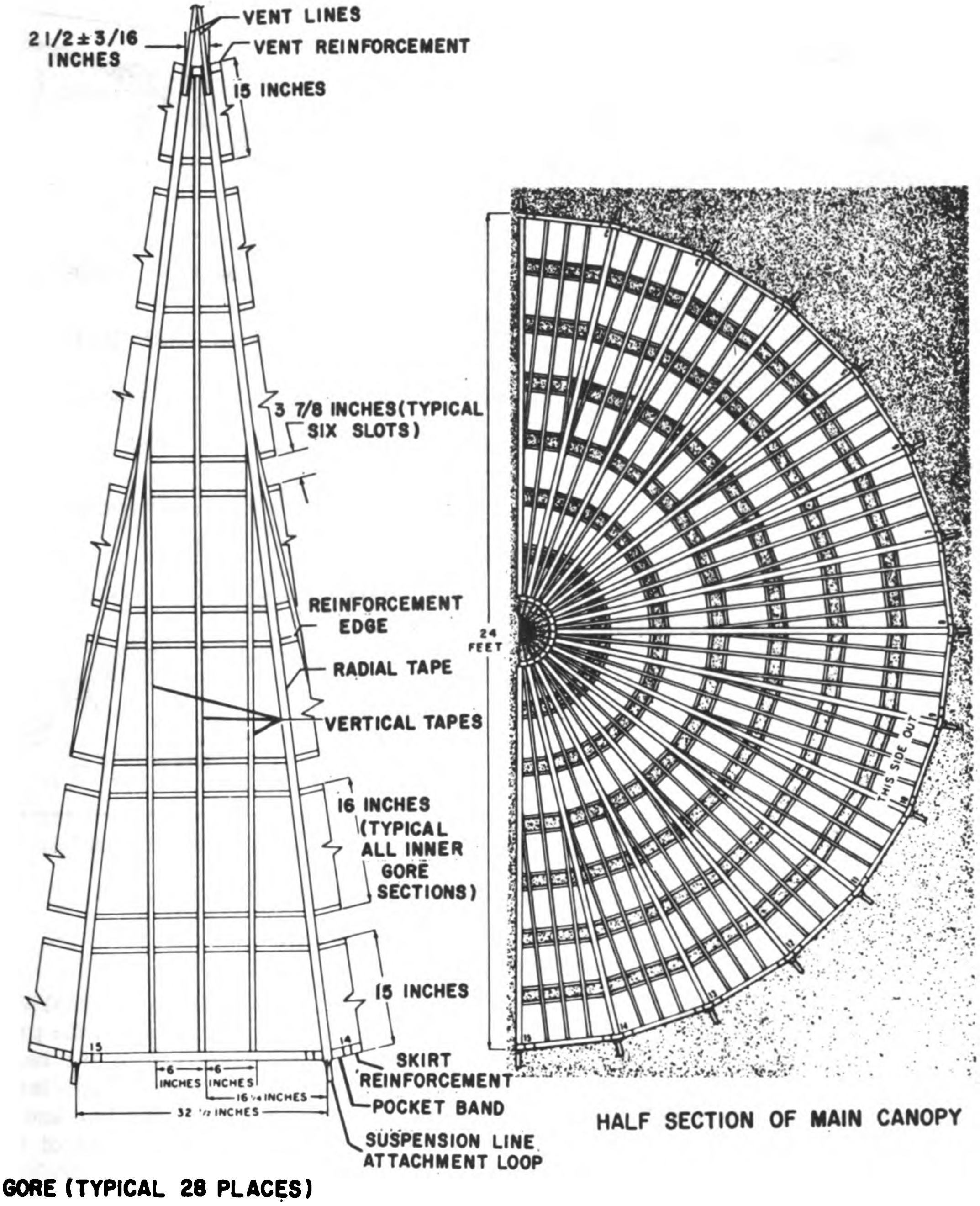
Figure 5-2 (A).—Deceleration parachute construction details; pilot parachute.

STRAIGHTENING LINES AND APPLYING TENSION.—Pick up line 1 in the right hand and line 28 in the left hand. Walk toward the connector links, shaking out and straightening the lines. Pass a steel bar (1/8 inch x 1-1/2 inches x 18 inches) or a length of double 550-pound nylon cord through the connector links with lines 1 and 28 up. (See fig. 5-5.)

INSTALLING RISERS.—Return toward the skirt, straightening each group of lines sewed to the connector links until all lines are free and straight from the canopy skirt to the links. Place lines 15 through 28 and corresponding gores on the right side of the table. Place the remaining connector links containing each group of suspension lines on the steel bar in the order shown in figure 5-6 with lines 10, 5, 1, 28, 24, and 19 up.

Place the riser assembly on the packing table adjacent to the connector links. Remove the connector links from the steel bar; separate the links to install the riser assembly. Attach the riser to the anchor point and apply tension to the parachute assembly. Proper amount of tension can be estimated by raising one suspension line approximately 1 foot off the tab and then releasing it. The line should spri back quickly to its original position. Separa the suspension lines into two groups by dividin the lines equally at the connector links, holdin one group in each hand and moving toward th skirt of the canopy. (See fig. 5-7(A).) Divid the gores equally into two groups with one the right side of the table and one at the le side, as shown in view (B).

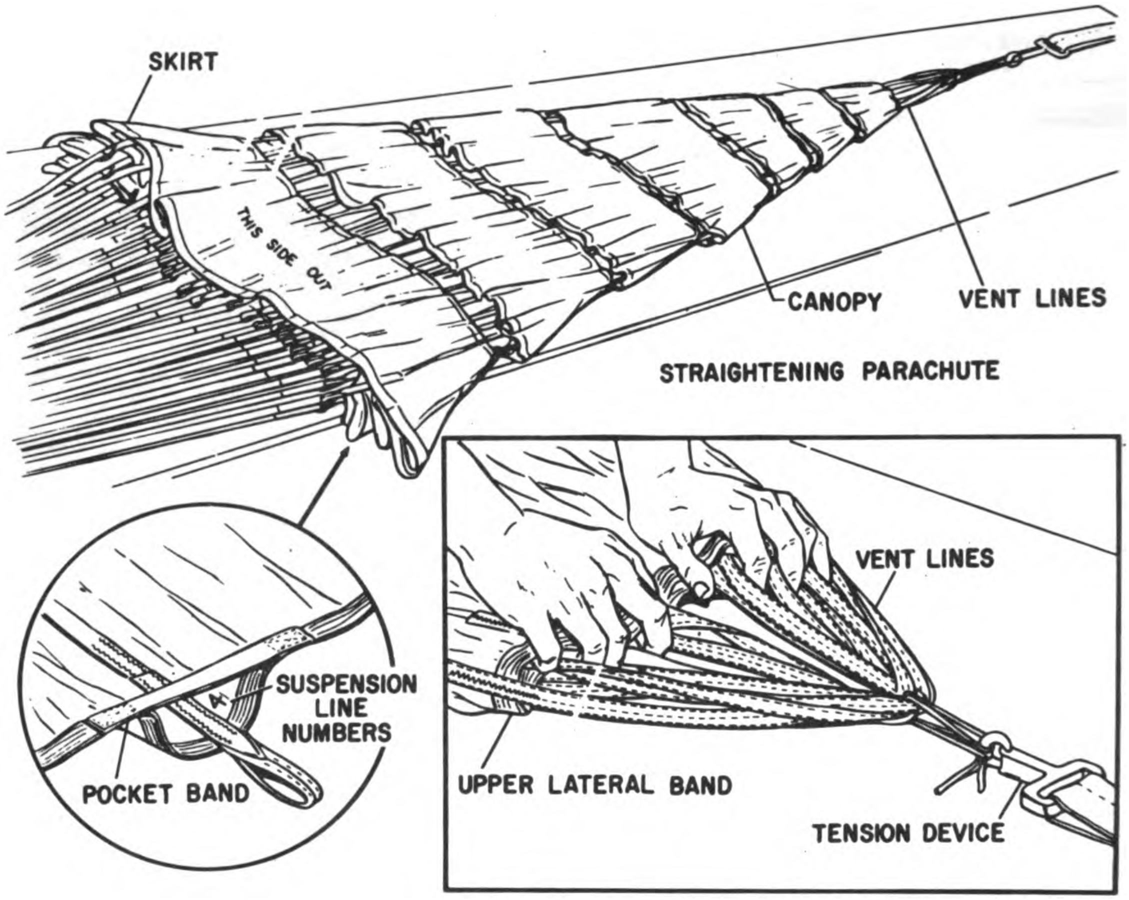
FOLDING CANOPY.—Where qualified Nav Parachute Riggers are available, the canop should be whipped and folded in the conventiona two-man-team method. Where such Riggers ar not available, the canopy should be folded b the following one-man method. Throw the gore from the right-hand side over the left-han gores, thus placing right-hand gore number 1 on top. Position a line holder at the skirt o the canopy. Pick up line 15, stretch and smoot the gore between lines 14 and 15, and then plac line 15 in the right-hand slot of the line holder (See fig. 5-8.) Similarly fold the remainin gores in the right-hand group in sequenc placing each gore directly over the precedin



(B)

Figure 5-2 (B).—Deceleration parachute construction details; main canopy.

ore and terminating with the gore between lines 27 and 28. Place weights on the right-hand group of gores. Throw the gores from the left-hand side over the right-hand group of gores. Fold the gore between lines 13 and 14. Place line 14 in the left-hand slot of the line holder. Similarly fold the remaining gores in the left-hand group in sequence, placing each gore directly over the preceding gore and terminating with the top-center gore between



STRAIGHTENING PARACHUTE

EQUALIZING VENT LINES

Figure 5-3.—Straightening parachute and equalizing vent lines.

lines 28 and 1. Place weights on both groups of gores.

All gores should now be in proper position with line 28 at the top of the right-hand slot in the line holder and line 1 at the top of the left-hand slot. Only the top gores between lines 28 and 1 and the bottom gore between lines 15 and 14 pass through the center. (See figure 5-9.) If a line holder is not available, shot bags or sandbags may be used to separate the line groups. (See fig. 5-10.)

Fold the outer edge of the gores toward the center on both sides so the width of the folded panels is approximately 20 inches. Secure folds in place with weights. Remove the tension attachment at the riser loop and at the vent. Leave weights or the line holder in place. (See fig. 5-10.)

INSERTING RISER IN DEPLOYMENT BAG.—Place the deployment bag on the packing table, positioning the open end of the bag toward th canopy with serial number up. Insert the loo end of the riser into the bag and through th small square hole in the end of the bag unti the riser extends approximately 30 inche through the hole. (See fig. 5-11.)

ATTACHING BRIDLE TO DEPLOYMEN BAG.—Thread one end of the bridle throug the small webbing loop adjacent to the squar hole in the deployment bag. Pass opposit end of the bridle through the loop and tighte (See fig. 5-12.)

STOWING RISER, SUSPENSION LINES, AN MAIN CANOPY.—A packing box is recommende to facilitate stowage of the riser, suspensio lines, and canopy in the deployment bag. (Se

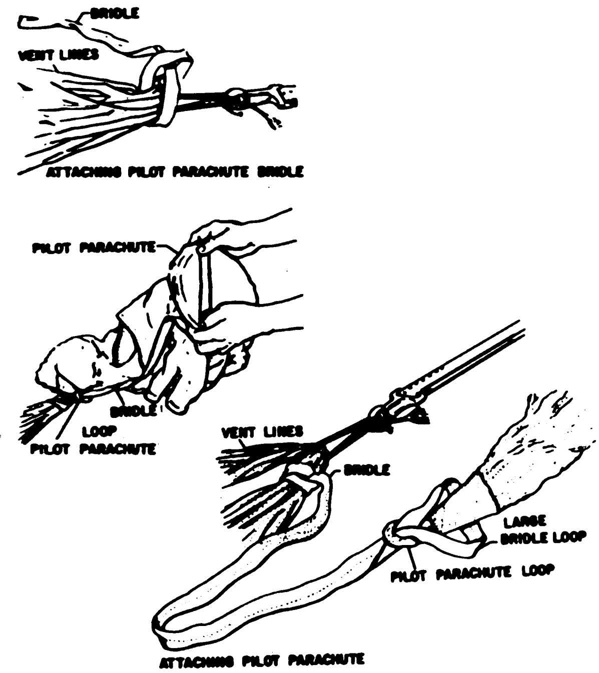


Figure 5-4.—Attaching pilot parachute bridle and pilot parachute.

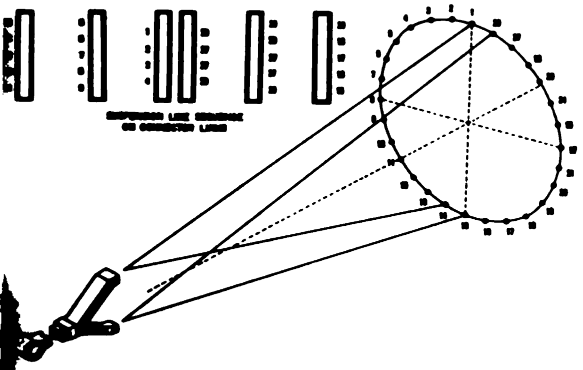


Figure 5-5.—Lines 1 and 28 up.

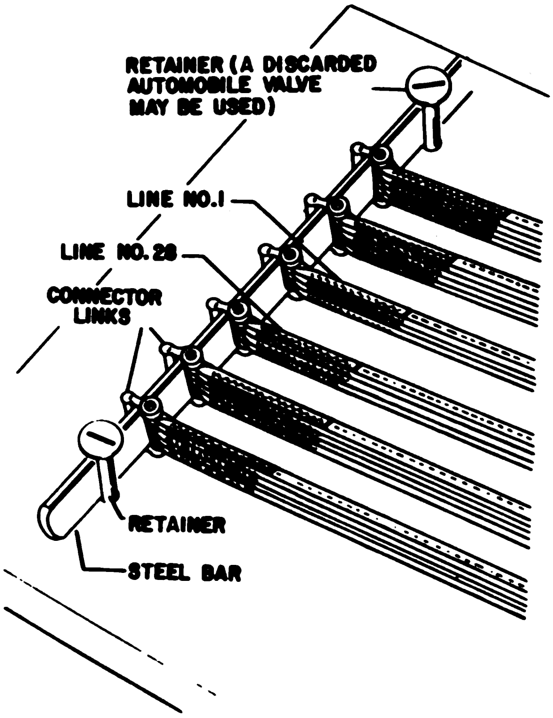


Figure 5-6.—Suspension line groups.

5-13.) (If a packing box is not available, e procedure may be accomplished with the ployment bag on a packing table.)

Place the deployment bag in the packing x. Extend the riser from the square hole the bag to the right-hand corner, pressing e riser webbing flat against the bottom of e bag. Stow the riser in the deployment bag accordian folds, placing the first fold on ge against the inside of the bag, then placing ch additional fold against the preceding fold. ch fold of the riser should extend across the full width (21 inches) of the deployment bag. After one layer of folds is tightly stowed, form the remaining length of the riser into a similar layer of folds on top of the first layer. (See fig. 5-14.) Cover the folded riser with the long protector flap (fig. 5-15) inside the bag. Fold the suspension-line stowage flap over the edge of the packing table. Position the first bight of suspension lines under hesitators and secure the glove fastener on each hesitator, as shown in figure 5-16. Note: This view shows the packing box rotated clockwise 90 degrees from the position shown in figure 5-15.

Stow the suspension line bights in all hesitators on the underside of the stowage flap. Fold the line stowage flap over the riser flap in the deployment bag and stow remaining lines under the hesitators on the upper side of the flap.

WARNING: Improper stowage can result in failure of the parachute to deploy properly. Line bights must not extend more than 1 inch beyond the edges of the stowage flap to prevent entanglement with lines stowed on the opposite side. Lines must be uniform without slack, looseness, twists, or loops. (See fig. 5-17.)

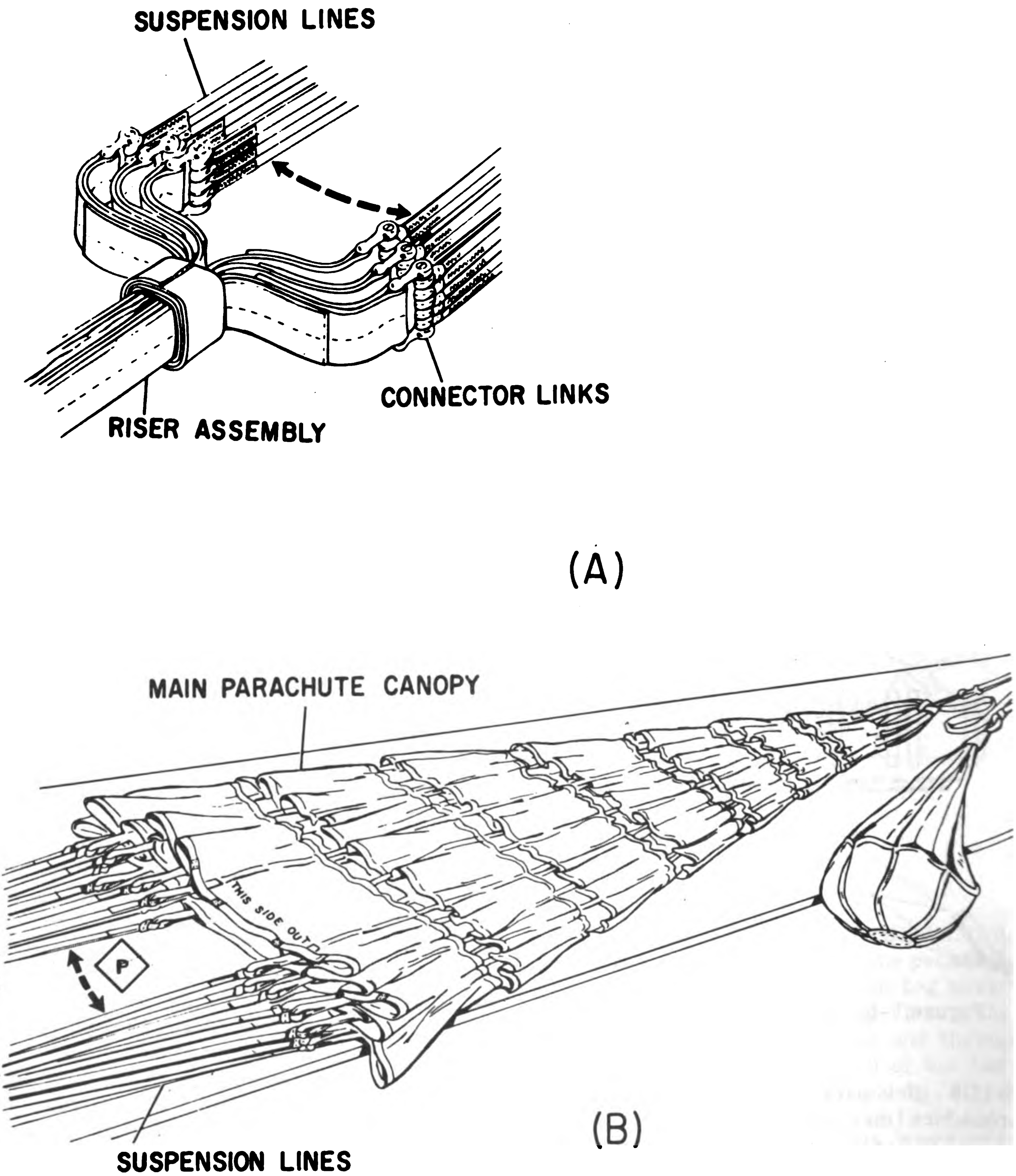


Figure 5-7.—Suspension lines divided into two groups.

Start canopy into bag in large accordion folds, placing the skirt in end of bag farthest from the packing table. Press each fold in place before starting the next fold, as shown in figure 5-18. Do not fold the vent and vent lines under the top fold of the canopy since fri tion burns may result during parachute deplo ment at high speeds. Rotate the packing box degrees counterclockwise so that the pil parachute bridle emerges from the left-ha

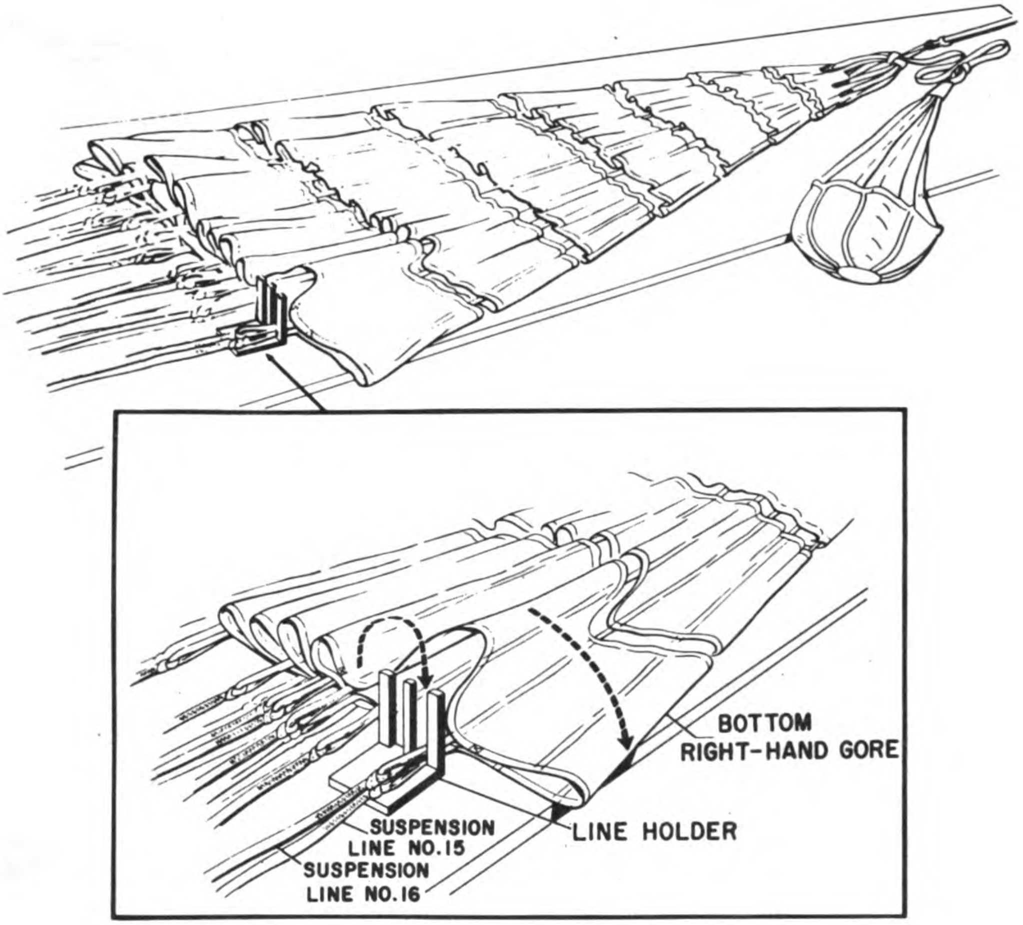


Figure 5-8.—Folding bottom right-hand gore.

orner of the deployment bag, as shown in igure 5-19.

CLOSING DEPLOYMENT BAG.—Place the ng closing flaps over the stowed canopy and ecure the locking loops with hooks or temporary cking pins. (See fig. 5-20.)

Hooks or pullup cords should be used when eplacing temporary locking pins with bights of e nylon webbing ripcord.

STOWING PILOT CHUTE.—Insert the pullup ord through the locking loop on the pilot parahute stowage flap. Compress the pilot parahute on the open stowage compartment. (See g. 5-21.) Fold flaps over the compressed hute, thread the pullup cord through the groment in each flap, then tighten the cord to reain the flaps in position. Secure the pilot arachute flaps with a temporary locking pin ithout removing the pullup cord from the locking loop. Insert deployment bag side flaps under bag closing flaps with a fid or by hand.

Inspection

Inspection periods and inspection procedures for the A3D parachute are indicated in table 5-1.

Repairs

Patching holes in pilot parachute, main parachute, or deployment bag, and splicing suspension lines or reinforcement webbing require equipment capable of sewing 3-cord nylon and are considered minor repairs. Major repairs are replacing vent and suspension lines, riser webbing, radial reinforcement webbing, gore sections of the main parachute canopy, and

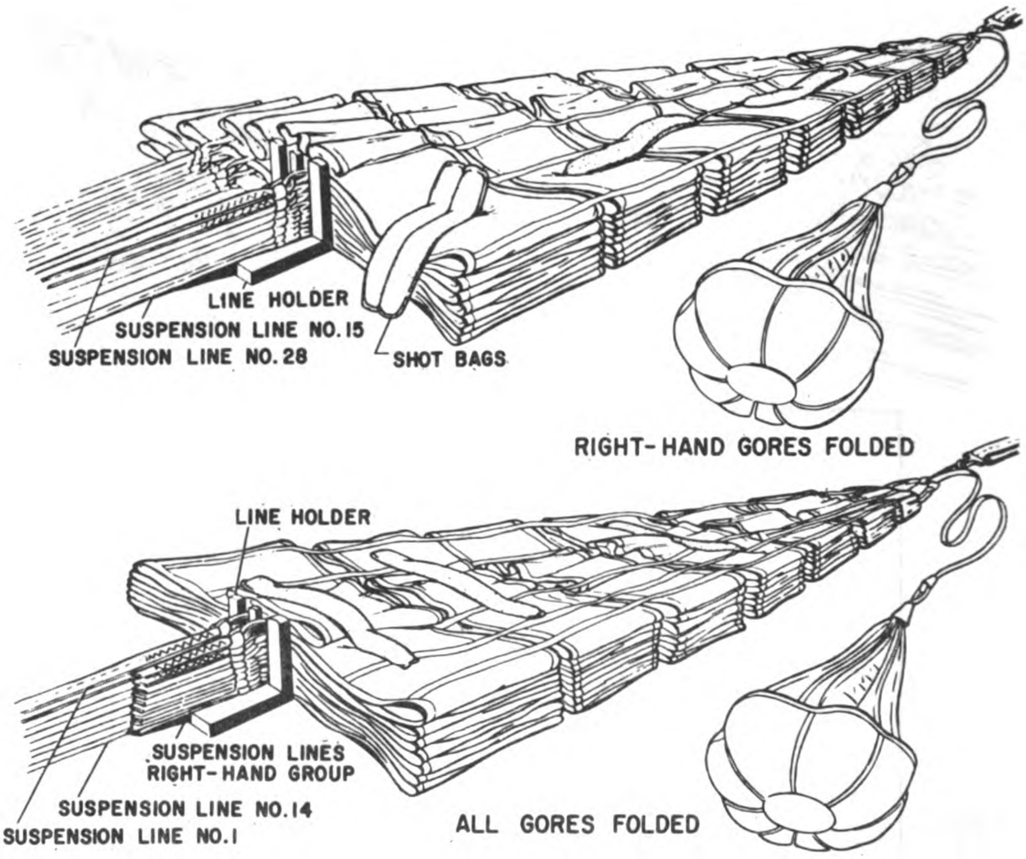


Figure 5-9.—All gores folded.

the canopy or vanes of the pilot parachute. These repair procedures are applicable to holes or tears from 1/4 inch to 4 inches in diameter or length. A single patch should cover two or more holes when the holes are closely spaced. Detailed repair procedures are outlined in the applicable aircraft manual.

CARGO PARACHUTES

Although the use of cargo parachutes is not a primary concern of the Navy, it is sometimes necessary for naval aircraft to engage in aerial cargo dropping operations. There are necessarily a number of types of cargo parachutes, since conditions and circumstances determine the kind of equipment and types of assemblies to be used. For example, supplies or equipment may have to be dropped to men in liferafts at sea, marooned on an island, in a jungle, or in a mountainous region. At other times it may be necessary to drop equipm behind enemy lines.

The occasion may arise when cargo par chutes and rigs have to be improvised. Wi a few adaptations, surveyed man-carrying ty parachutes may be used. All such parachut must be stenciled "CARGO" in large lette to assure that the units are never returned man-carrying service.

The cargo parachutes discussed in t section are standard U.S. Air Force equ ment and are available to naval activiti through regular supply channels.

Types G-1 and G-1A

Types G-1 and G-1A cargo parachutes a used in conjunction with various containe cartons, packs, and slings designed especi for handling and enclosing supplies and equ ment most likely to be delivered by air.

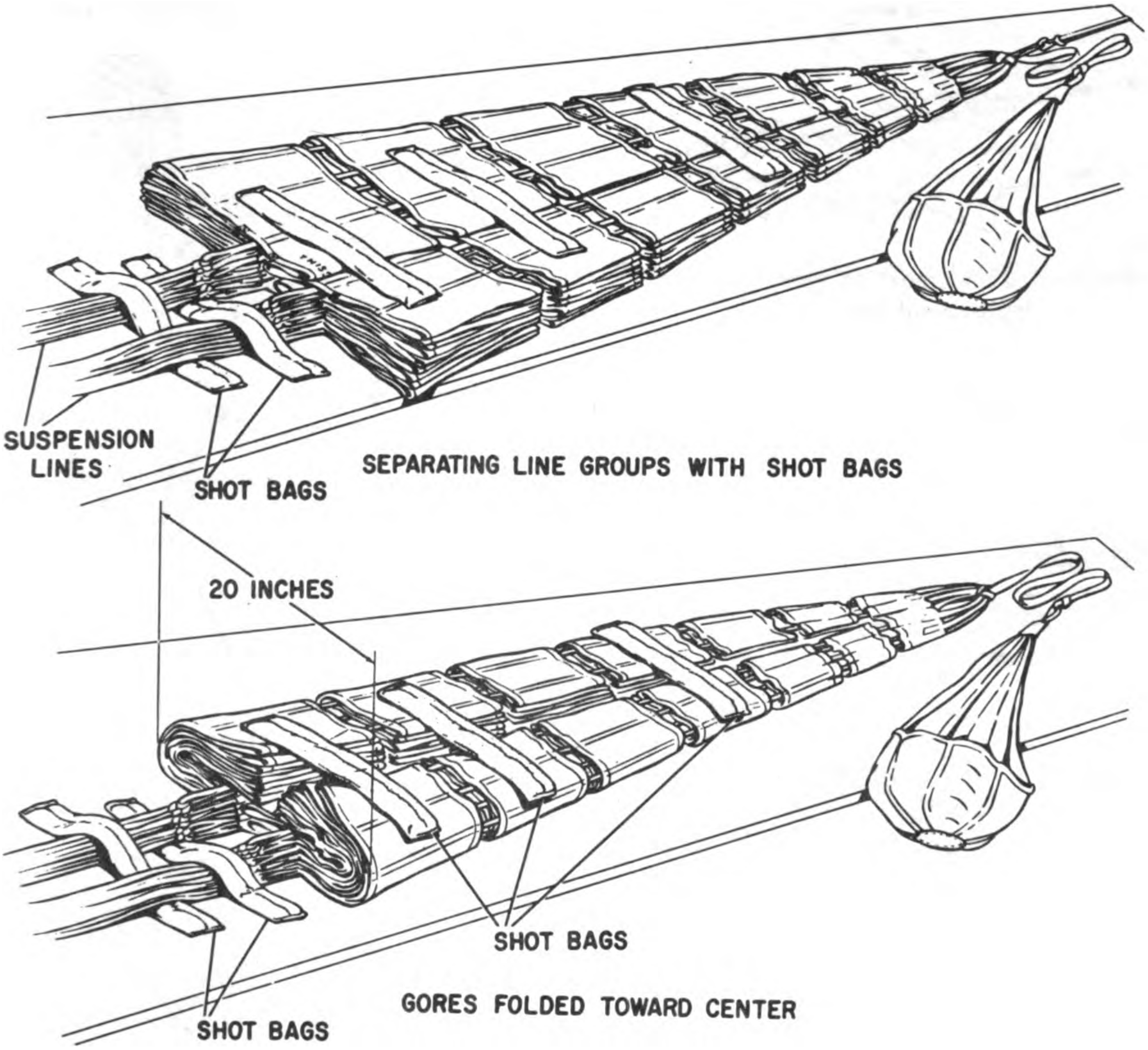

SUSPENSION LINES
SHOT BAGS
SEPARATING LINE GROUPS WITH SHOT BAGS
20 INCHES
SHOT BAGS
GORES FOLDED TOWARD CENTER
SHOT BAGS

Figure 5-10.—Separating line groups with shot bags.

The canopies and lift webs for the G-1 ad G-1A are identical; however, different acks are used. The pack for the G-1 is com-osed of two parts—the pack body and the ack cover, with the static line a part of ie cover. The pack for the G-1A is a one-art unit with the static line forming a sepa-ate assembly.

DESCRIPTION OF CANOPY.—The flat, cir-ular type canopy shown in figure 5-22 and 5-23 s 24 feet in diameter and has a 12-inch di-meter vent at the apex. This canopy is made of 4 one-piece solid rayon gores, and is issued in ive different colors—green, light blue, natural, red, and yellow. There is no limitation to the service life of the G-1 or G-1A parachutes.

Lengths of rayon tape, referred to as upper and lower lateral bands, reinforce the assembly by encircling the canopy inside the skirt and vent hems. On some canopies a lower lateral band outer reinforcement is sewed to the inner circumference of the skirt and is looped loosely around each suspension line.

The 24 suspension lines are actually made of 12 lengths of rayon tape, with each length of tape running continuously over the canopy from connector loop to connector loop. Unstitched areas of suspension lines on the canopy

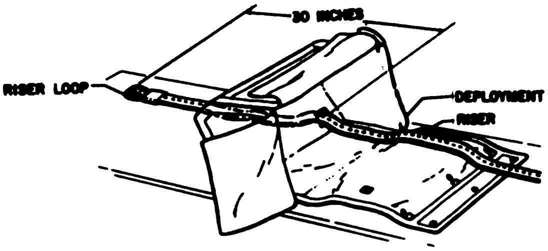


Figure 5-11.—Inserting riser in deployment bag.

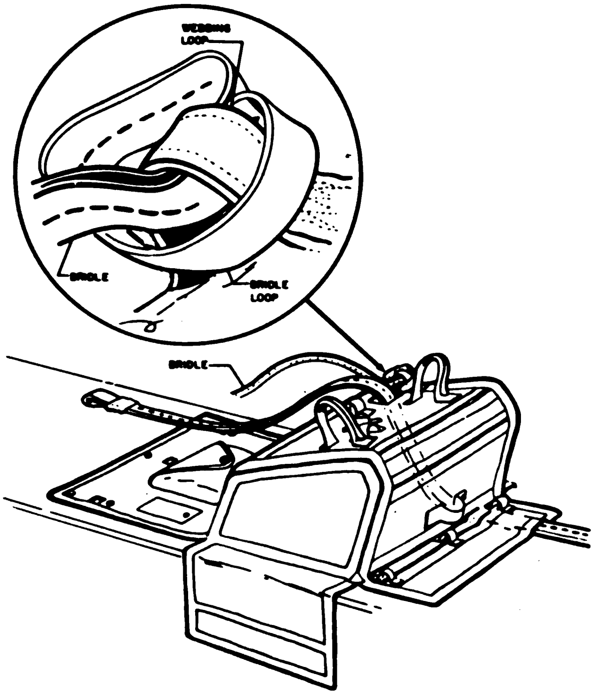


Figure 5-12.—Attaching deployment bag bridle to bag.

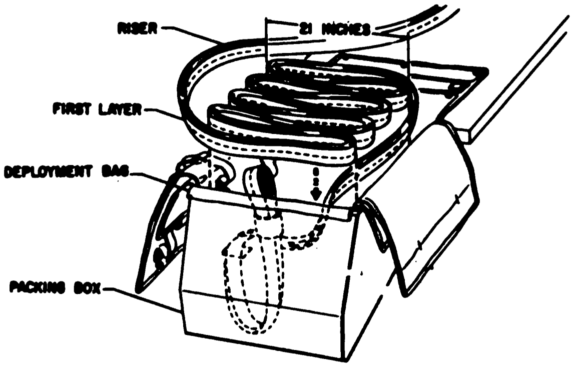


Figure 5-13.—Stowing riser.

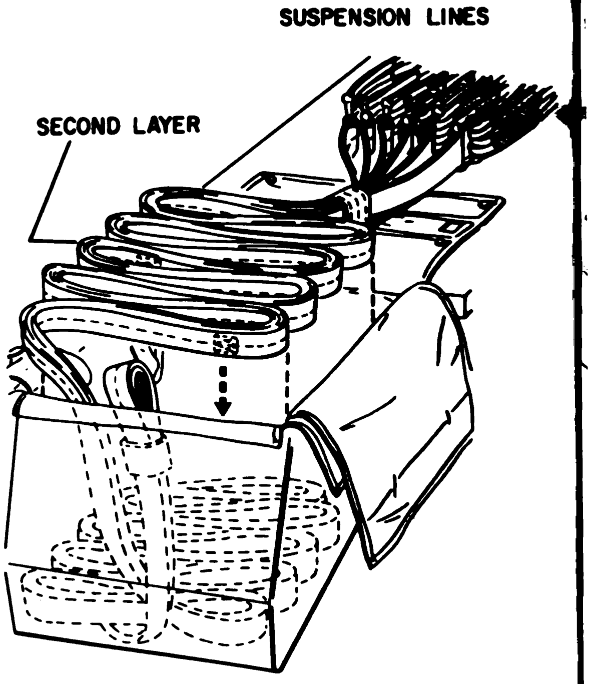


Figure 5-14.—Accordion folds of riser.

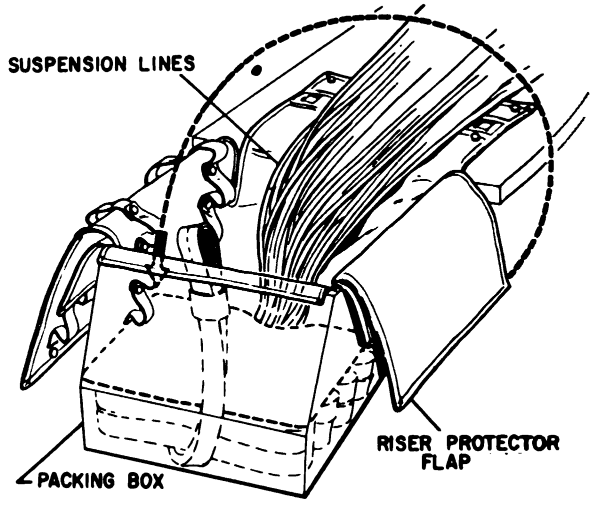


Figure 5-15.—Riser protector flap.

are protected by radial bands which form channels for the lines. Two lift webs are separated by a spreader, and the suspension lines are attached to the connector loops.

INSPECTION.—Check the entire surface of each gore for holes, tears, weak spots and any foreign materials such as mildew, rust, water, oil stains, and battery acid that cause

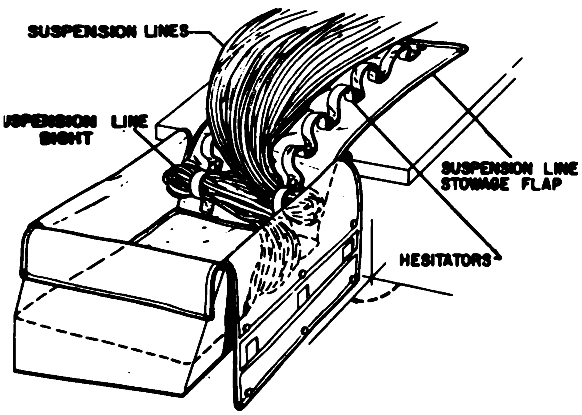


Figure 5-16.—Packing box turned 90 degrees and first bight taken.

fabrics to deteriorate rapidly. Check each seam at canopy skirt, channel radial bands, and vent for holes, tears, and loose or broken stitching.

CANOPY REPAIRING.—Loose or broken stitching areas can be restitched without removing the old stitching. Use natural, size E nylon thread. Stitch 8 to 10 stitches per inch, using Singer Model 31-15 sewing machine or equivalent for the tape.

Darning.—Darn holes or tears not exceeding 1 inch in length with size E nylon thread. The procedure for darning is the same as given for personnel parachutes in *PR 3 & 2*, NavPers 10358-A.

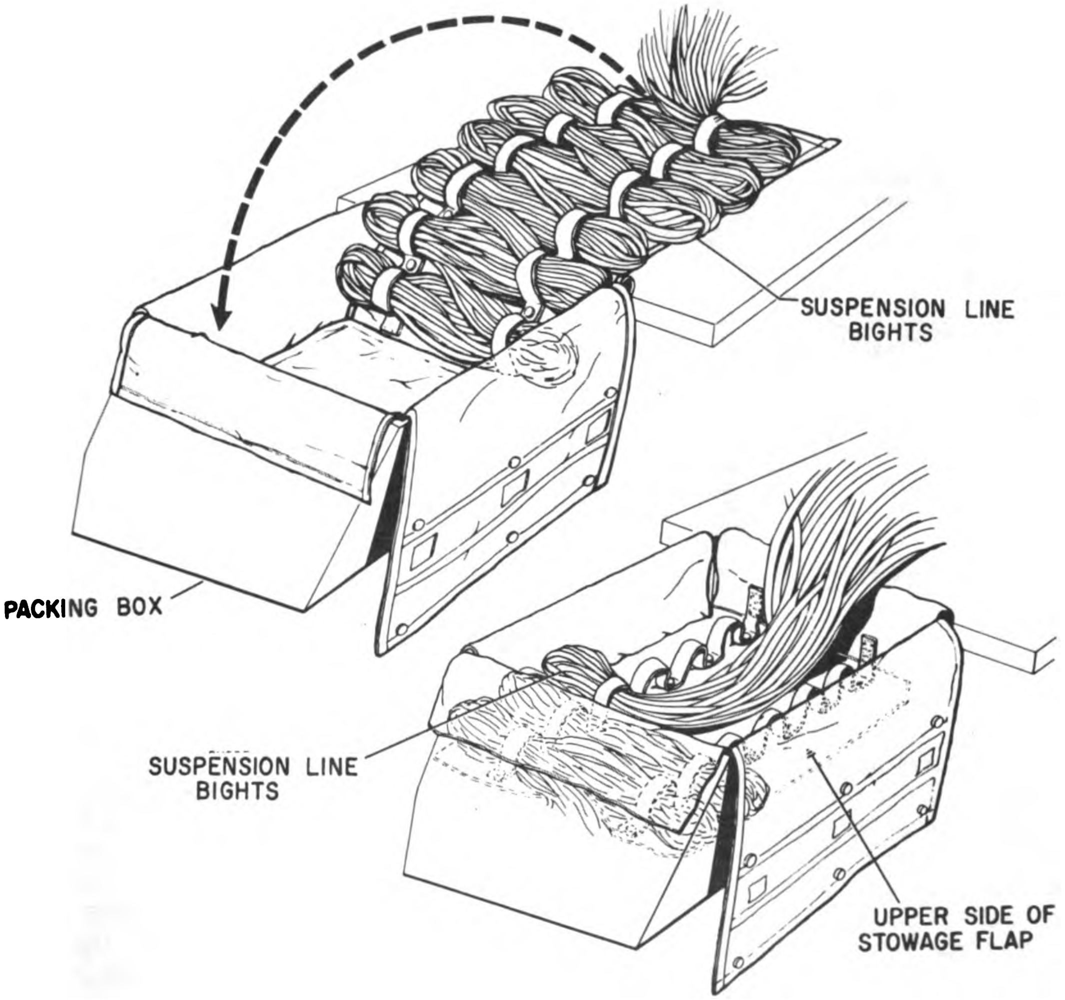


Figure 5-17.—Suspension lines stowed in lower side of stowage flap.

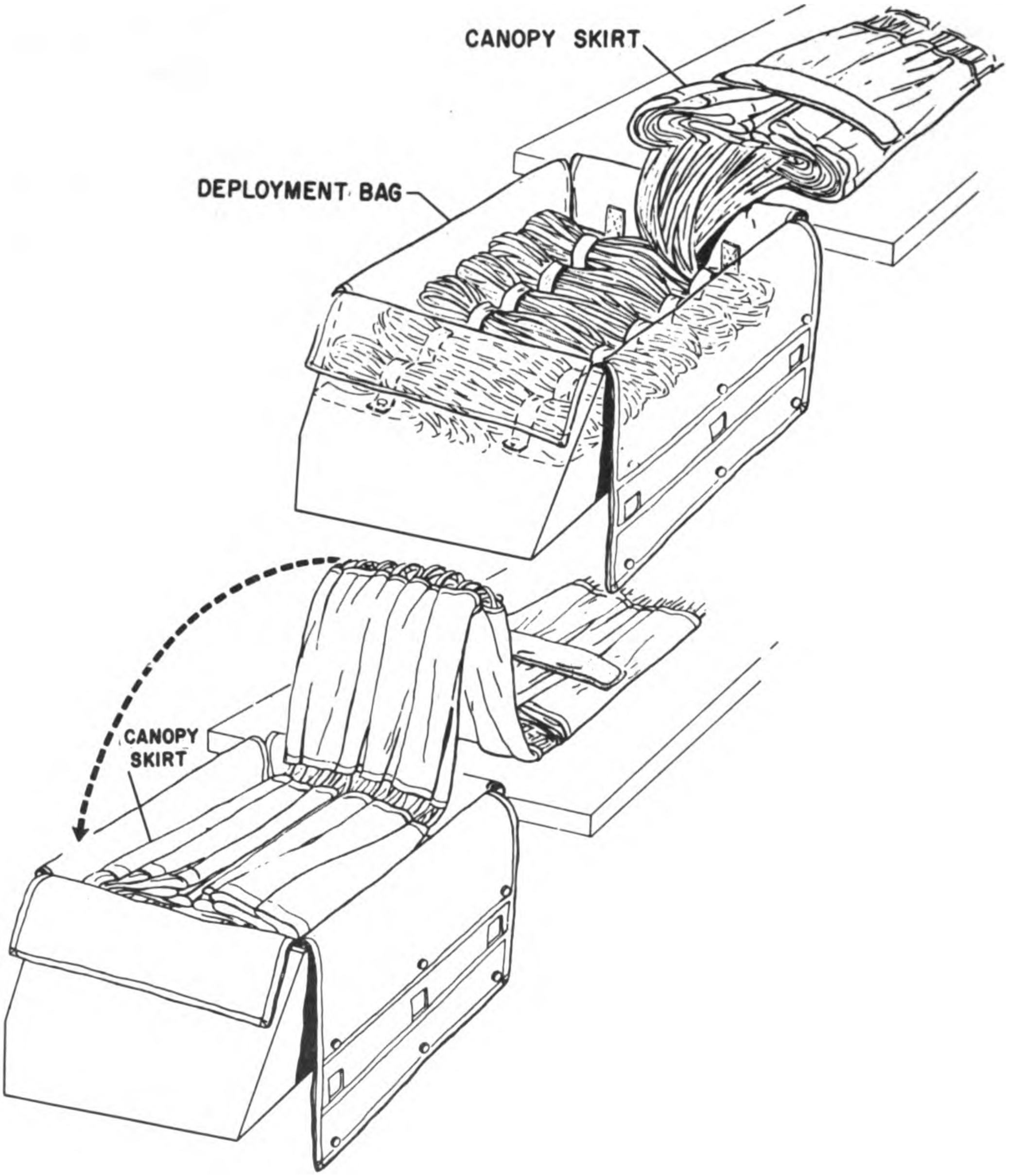


Figure 5-18.—Stowing main canopy.

Rectangular Patching.—Damaged areas that do not extend to any of the gore seams may be repaired with rectangular patches as follows:

1. Turn the canopy inside out and lay it out on the repair table, centering the gore to be patched on the table.

2. Place a patch pattern that is 3 inches longer and 3 inches wider than the damaged area on the material to be used for patching so that the edges of the pattern are parallel to the warp and filler of the material. Mark the material according to the pattern. Cut the patch from the material according to the marking.

3. Fold back the edges of the patch 1/2 inch and baste with thread, using 2 stitches per inch. Place the patch over the hole to be patched, making sure the warp and the filler of the patch and of the canopy gore run parallel to each other. Baste the patch to the gore, using 2 stitches per inch.

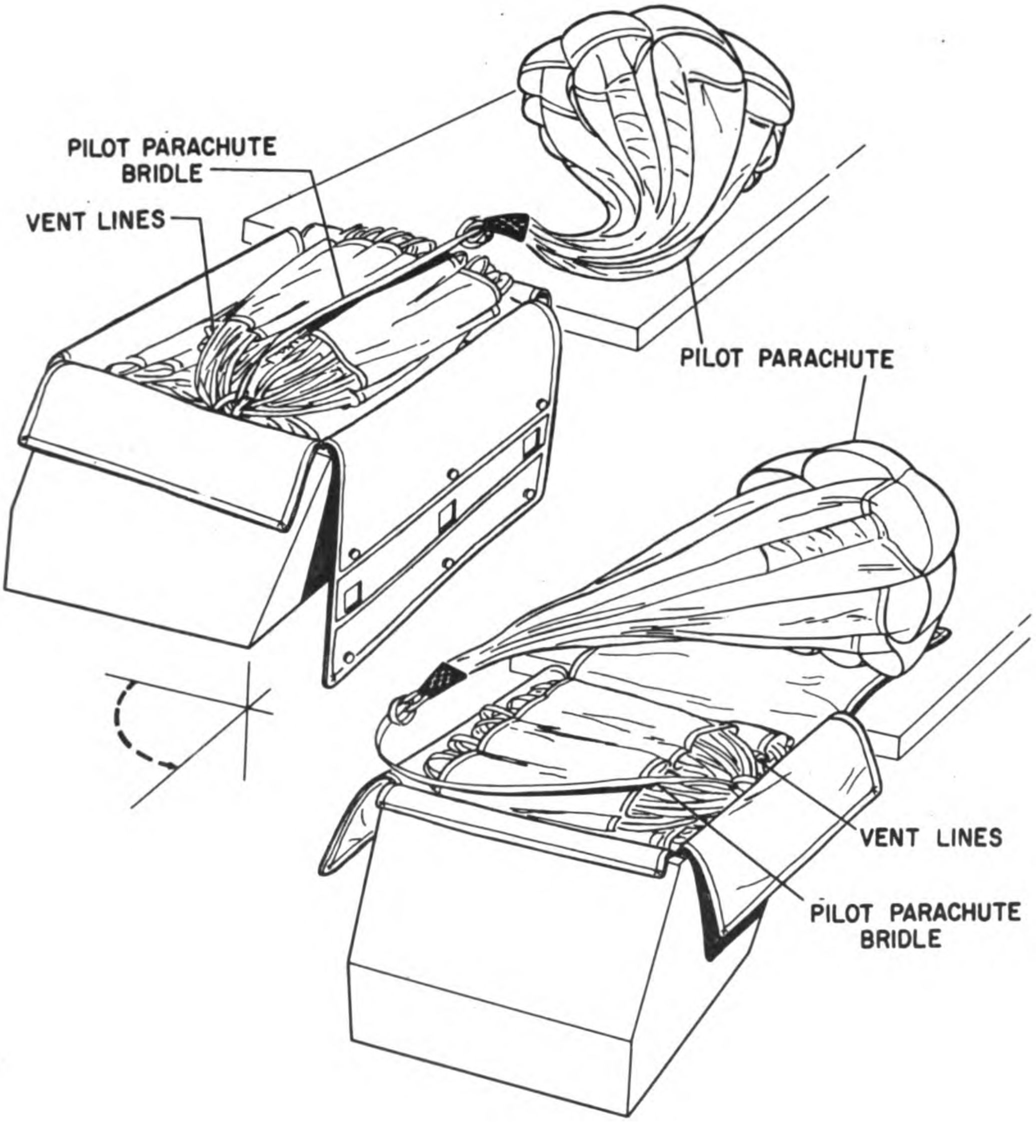


Figure 5-19.—Bridle emerging from left-hand corner of deployment bag.

4. Stitch the patch on the canopy by sewing at the edge of the patch, using natural, size E nylon thread. Stitch 8 to 10 stitches per inch, using Singer Model 31-15 sewing machine or equivalent. Place the first row of stitches 1/16 inch from the edge of the patch. Sew completely around the patch and overlap the stitches 2 inches to make secure.

Turn the canopy right side out and cut out the damaged material around the hole. Fold under the edges of the material around the hole 1/2 inch and baste. Sew completely around the patch 1/16 inch from edge of the hole, overlapping the stitches 2 inches. Remove the basting and place a third row of stitches between the other two rows. Sew completely around the patch and overlap 2 inches.

Channel-to-Channel Patching.—A large damaged area may be repaired with a channel-to-channel patch up to 5 feet in length. The patch may extend to either the lower or upper lateral band seam, depending on the location of the damaged area.

The procedure is the same as for the rectangular patching with the following exceptions:

If the patch is to cover a lower lateral band that is equipped with a reinforcing tape, remove the stitches and raise the tape so that the patch

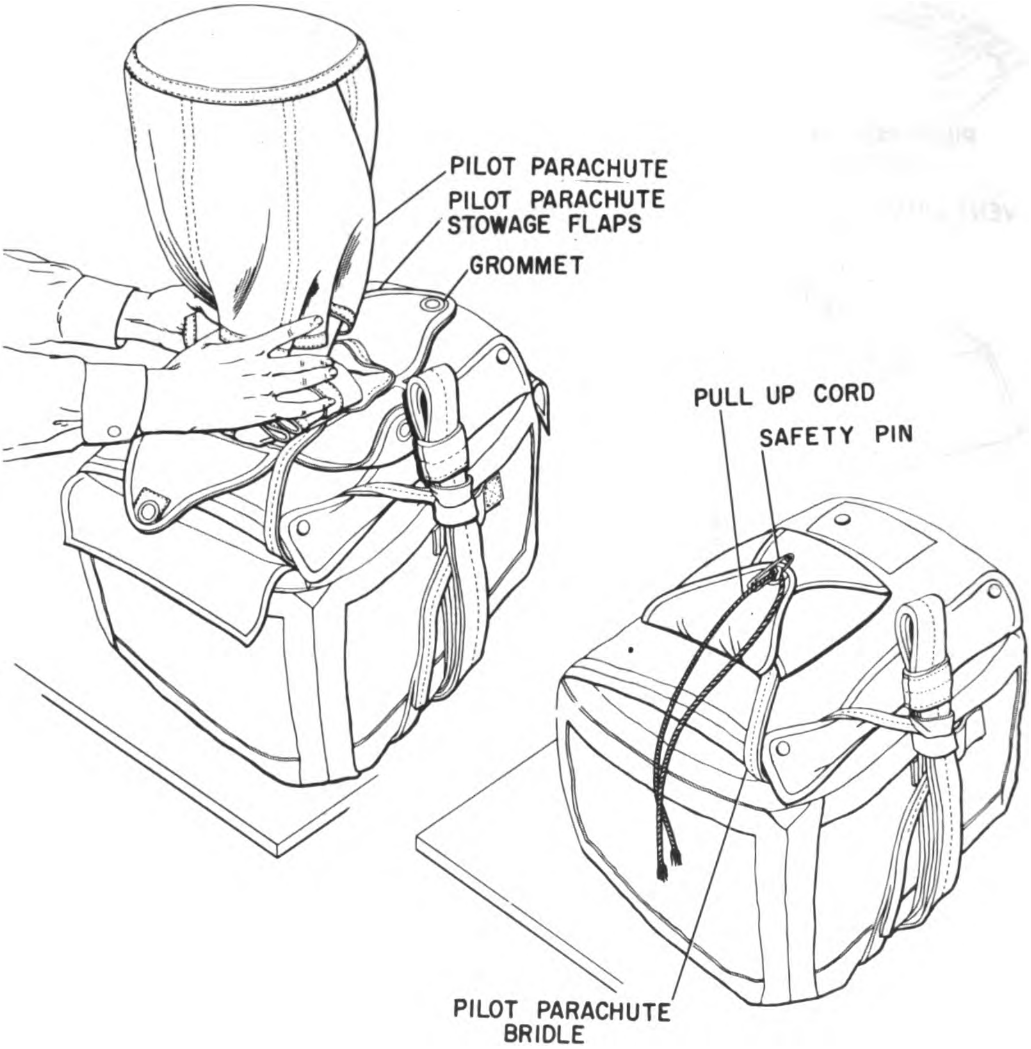


Figure 5-20.—Closing deployment bag.

may be installed under the tape. If the lower lateral band reinforcing tape is loosened, replace with a double row of stitching. Reproduce as closely as possible all stitching that was removed.

Replacement of a Gore.—If a channel-to-channel patch cannot be used to repair a gore adequately, the badly damaged gore may be replaced as follows:

1. Remove the suspension line channel radial bands on both sides of the damaged gore.
2. To cut the gore or to prepare a pattern for the gore, refer to figure 5-24. From point A, measure 12 feet 11 inches along the selvage edge to find point B. From point A, measure 3 feet along a perpendicular to find point C. Connect points B and C. From point B, measure 12 feet 11 inches back along line BC to find point D. Connect points D and A. To find line EF, slide a rule back from point B until perpendicular line EF measures 2 3/4 inches. Cut the gore or pattern along lines ADEF. In cutting the gore, line AB must always lie along the selvage edge or parallel to it.
3. Install the new gore, adapting the procedure given for channel-to-channel patching. Replace the suspension line channel radial bands.

Splicing the upper lateral band is accomplished in the same manner as given for splicing the lower lateral band. The upper lateral band is not replaceable.

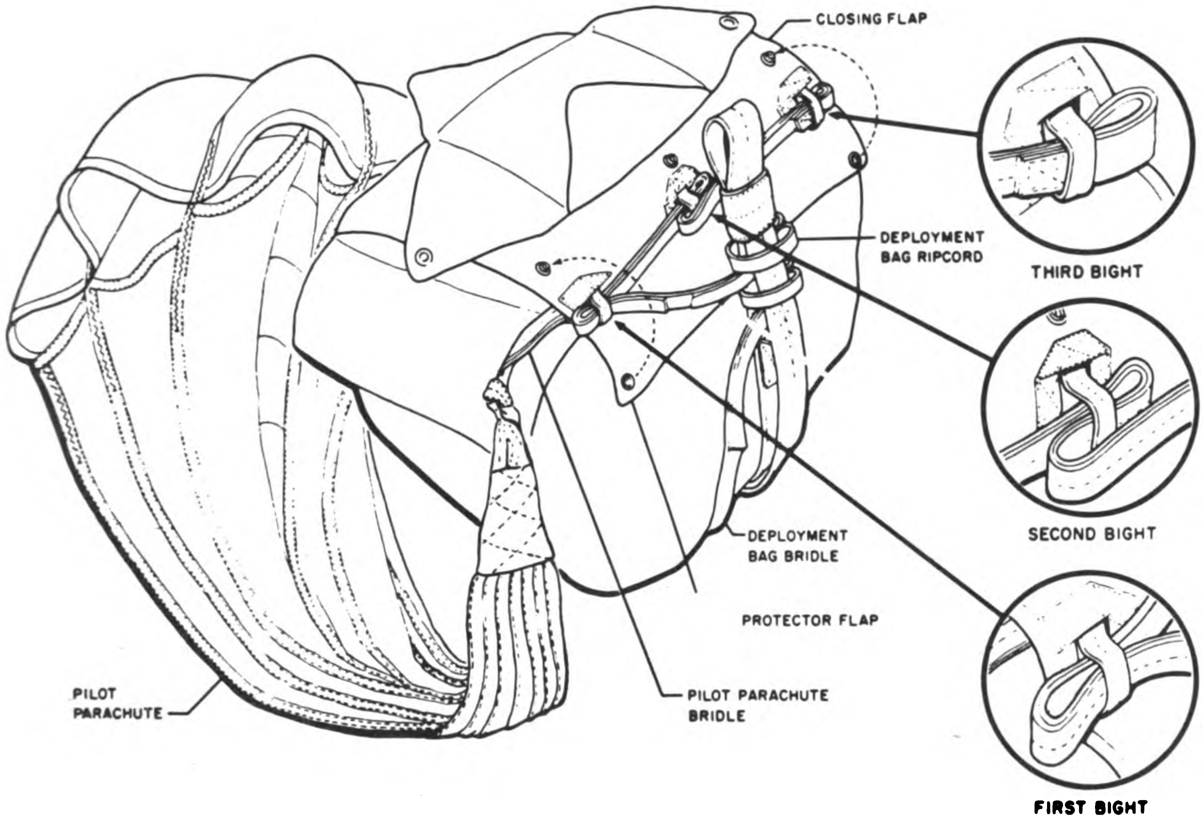


Figure 5-21.—Inserting pilot chute.

REPAIRING SUSPENSION LINES.—The 24 suspension lines are made of 12 lengths of natural, 1/2 inch wide, type II rayon tape. Each length of tape is approximately 56 feet 10 inches long when measured under a 10-pound tension. Each suspension line is 15 feet long from the edge of serving on the connector loop to the skirt of the canopy.

Splicing the suspension line is done in the same manner as given for splicing the lower lateral band.

Suspension lines may be replaced as follows:

1. Remove stitching that secures the damaged line to canopy and the connector loops. Remove servings and tape at appropriate connector loops and remove damaged line.
2. Place new suspension line under a 10-pound tension and cut a 57-foot 4-inch length. The length of the new suspension line is 6 inches longer than the required length of the suspension line to allow for any margin of error, since other undamaged lines may have been stretched with use of the parachute.
3. Dip the ends of new line in a paraffin-beeswax mixture. Place the line through the proper channel radial bands on the canopy.
4. Place the new line in proper position with the other lines at connector loops. Lay parachute out on the packing table and apply equal tension to new and old suspension lines.
5. Form a 3-inch loop, making certain that any excess line is cut off before final sewing and serving; using 5 to 7 stitches per inch on a 7-31 sewing machine to secure the lines. Wrap the loop with 1-inch adhesive tape. Make two 1-inch servings 5 inches apart using cotton 6 cord.

REPAIRING LIFT WEBS.—The lift web assembly consists of two webs 34 inches long and a spreader made of natural, type VIII, cotton webbing. Lift web snaps are attached to the ends of the lift webs.

Lift webs, spreader, and snaps should not be repaired. The lift web assembly may be replaced as follows:

Fabricate lift webs with type VIII cotton webbing and attach as shown in figure 5-25. Stitch

Table 5-1.—Inspection procedures for A3D deceleration parachute.

Inspection period	Item	Inspect for	Corrective action
10-day	DEPLOYMENT BAG	Presence of moisture, mildew, oil or acid stains, wear and tear.	If condition warrants more thorough inspection or repair, remove parachute from airplane, unpack parachute, and inspect in accordance with 60-day inspection procedures.
	DEPLOYMENT BAG BRIDLE AND RIPCORD PILOT PARACHUTE BRIDLE RISER	NOTE: If parachute is installed inspect only portions of items visible without removing parachute from container or opening container doors.	WARNING: Remove parachute from airplane if moisture is present. Pilot parachute or main canopy may freeze during cold weather or high altitude operation and result in parachute failure or deployment.
60-day After each use.	PILOT PARACHUTE	Holes, open seams, or friction burns in canopy, vanes, and central cone.	Mark holes exceeding 1/4 inch in diameter, severe friction burns, and open seams. Patch holes and burned areas. Repair seams. NOTE: Pilot parachute is serviceable when vanes contain holes under 2 inches in diameter. Repair of such holes may be delayed until appropriate repair facilities are available.
		Breaks in suspension lines and reinforcement webbing.	Mark damaged suspension line or webbing. Replace suspension line. Repair damaged reinforcement webbing.
		Breaks or sharp bends in ejection spring by feeling wire through fabric.	Replace pilot parachute.
		Presence of moisture.	Suspend parachute assembly in loft for thorough drying.

Table 5-1.—Inspection procedures for A3D deceleration parachute—Continued

nspection period	Item	Inspect for	Corrective action
0-day fter each use.	PILOT PARACHUTE BRIDLE	Breaks, wear, broken warp threads, or abrasion.	Replace pilot parachute bridle.
0-day	MAIN PARACHUTE		
fter each use.	Gore sections.	Holes, tears, friction burns, and severe abrasions.	Mark all damaged areas. Patch holes (1/4 inch to 4 inches in diameter) and tears under 4 inches long. Replace entire gore section if holes or tears exceed 4 inches in diameter or length or if extent of damage from friction burns or abrasions cannot be determined accurately.
	Gore section hems. Skirt and vent reinforcement bands. Radial tapes. Vertical tapes. Pocket bands.	Breaks, tears, friction burns, abrasions, and areas of broken or missing stitches.	Mark all damaged areas. Splice broken or damaged reinforcement bands, radial tapes, and vertical tapes. Replace damaged pocket bands. Replace all broken or missing stitches extending more than 1/2 inch in length except in vertical tapes.
	Vent lines.	Breaks, broken warp threads, marked discoloration (straw yellow), friction burns, tears, abrasions, and areas of broken or missing stitches.	Mark damaged vent line. Replace vent line having any one of these defects: breaks, more than 14 broken warp threads, or discoloration. Replace vent line if extent of damage from friction burns or abrasions cannot be determined accurately. Replace all broken or missing stitches extending more than 1/2 inch in length.

Table 5-1.—Inspection procedures for A3D deceleration parachute—Continued

Inspection period	Item	Inspect for	Corrective action
60-day—Continued	MAIN PARACHUTE—Continued		
After each use.	Suspension lines.	Breaks, broken warp threads, marked discoloration (straw yellow), friction burns, tears, abrasions, and areas of broken or missing stitches in half-hitches at each end of line.	Mark damaged suspension line. Replace suspension line having any one of these defects: breaks, more than 14 broken warp threads, marked discoloration, and burn or abrasion which extends across line and sever any warp thread. Replace suspension line if extent o damage from friction burns o abrasions cannot be determine accurately. Replace all broken or missin stitches extending more than 1/ inch in length. NOTE: Damaged suspension line may be spliced if major repai facilities are not available. A spliced lines, however, must b replaced when the parachute assembly arrives at a major repa facility.
	Suspension line attachment loop.	Breaks, friction burns, abrasions, and areas of broken or missing stitches.	Mark damaged loop. Replace all broken or missi stitches. Replace broken, burned, or severely abraded attachment loop
60-day	RISER	Broken stitching, tears, breaks, broken warp threads, friction burns, abrasions.	Mark damaged area. Replace entire riser if any webbing is broken, burned, or severely abraded.
	Loop.	Breaks, friction burns, broken stitching, size and shape of loop opening for conformity to riser link and spacer.	Replace entire riser if loop contains any broken webbing, or i loop is severely deformed o burned.
	Keepers and separators.	Breaks, friction burns, abrasions, broken stitching.	Mark damaged keepers or separators.

Table 5-1.—Inspection procedures for A3D deceleration parachute—Continued

Inspection period	Item	Inspect for	Corrective action
60-day—Continued	RISER—Continued		Replace damaged keepers or separators.
	Connector links.	Burrs, loose screws, abrasions.	Mark damaged connector links. Tighten and restake screws. Remove burrs with fine emery cloth. Replace severely abraded links.
0-day	DEPLOYMENT BAG LOCKING WEBBING (RIPCORD) AND BRIDLE	Breaks, wear, broken warp threads, abrasions.	Mark damaged ripcord or bridle. Replace damaged ripcord or bridle.
0-day	DEPLOYMENT BAG	Holes, tears, friction burns, abrasions, broken reinforcement webbing, torn or missing loops, stowage flaps or closing flaps, broken or missing stitches.	Mark all damaged areas. Patch holes in fabric. Repair or replace loops, closing flaps, or stowage flaps. Splice reinforcement webbing.

to 8 stitches per inch, using a 7-31 sewing achine.

Fabricate the lift web spreader from the same pe webbing, and attach as shown in figure 5-26. se same stitches and sewing machine as for e lift web.

DESCRIPTION OF G-1 PACK.—The G-1 pack onsists of two main parts, the pack body and the ack cover. A 15-foot static line is attached ermanently to the cover.

Pack Body.—The pack body is 12 inches quare and 3-3/4 inches high with an open end. he bottom consists of inner and outer squares f heavy duck, with an enclosed plywood base r easier handling. There are nineteen 1/4-ch brass grommets and one 3/8-inch brass rommet around the open end edge of the side f the pack body. Tiedown webs are sewed to e inner bottom of the pack body with web ends assing through the corners of the pack body.

Pack Cover.—The pack cover is 12 1/8 ches square and 6 1/2 inches high with an open end which fits over the pack body. There are sixteen 1/4-inch brass grommets and four 3/8-inch grommets around the edge of the side of the pack cover. The larger grommets are located where the ends of the static line webs meet the edge of the pack cover. The static line webs are sewed to the inside of the pack cover. The 15-foot static line is looped through the pack cover and around the static line webs where the webs cross at the loop hole in the pack cover top. Figure 5-27 shows the inside of the pack body and cover.

REPAIRING PACK BOTTOM AND COVER.—Restitching and darning the pack bottom and cover may be done by following the same procedure as for restitching and darning the canopy. Holes or tears that are more than 3/4 inch in diameter or length require patching. Patch the side or bottom with the same type material used in the original construction. The type of patch used depends on the location and the extent of the damage. When patching, use 6 to 8 stitches

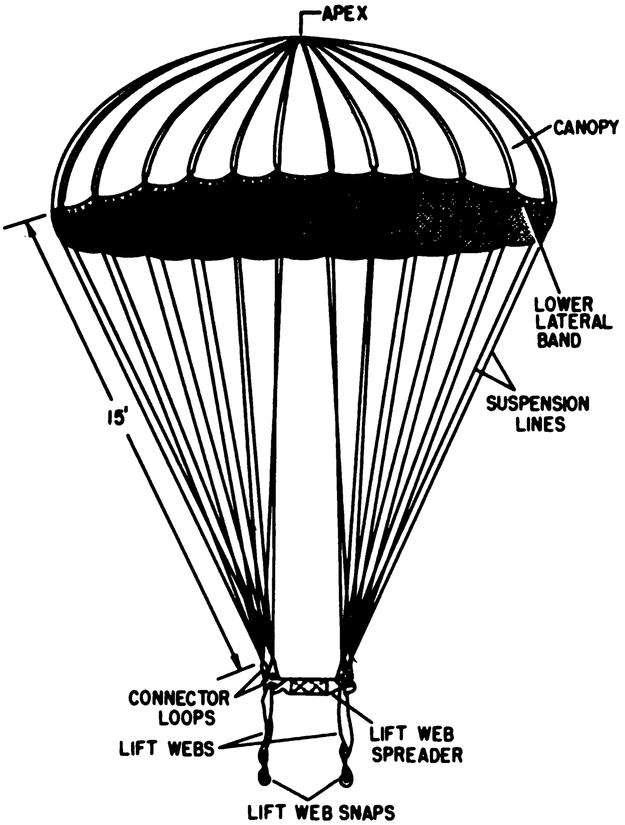


Figure 5-22.—G-1 and G-1A parachutes, showing canopy and lift webs.

per inch with a 111 W 151 sewing machine or equivalent.

PARACHUTE LOG RECORD POCKET.—The parachute log record pocket is located in the bottom of the pack body, and is made of the same material as the pack body side and bottom. There is a pull tape for ease of removing the packing card. The binding tape and pull tape are made of 3/4-inch, type III, cotton reinforcing tape.

STATIC LINE.—The static line is made of natural, type VIII, cotton webbing and is provided with a static line snap. The static line should not be repaired; it should be replaced.

Replace the static line by removing the damaged line from pack cover and fabricating and installing a new line. Use 6 to 8 stitches per inch, using a 7-31 sewing machine.

DESCRIPTION OF G-1A PACK.—The G-1A pack and static line, unlike the G-1 pack and static line, are separate assemblies.

The G-1A pack is a single unit, consisting of a cotton duck side panel and inner and outer bottom panels. (See fig. 5-28.) The four cover flaps are part of the same piece of duck as the side panel, with the cover loops formed from the cover loop strap. A top reinforcing strap is attached to the outside of the pack beneath the flaps, with two static line retaining straps attached to the top reinforcing strap. Two suspension line retaining band keepers are attached to the inner bottom panel, and four pack tiedown straps are attached near the four bottom corners.

The static line is a mildew-proofed, 15-foot 4-inch length of olive drab, type VIII cotton webbing with a snap at one end, an attaching loop at the other end, and a pack opening loop 4-3/4 inches from the attaching loop.

REPAIRING.—The restitching, darning, and patching is done in the same manner as given for the G-1 pack.

G-1 PACKING PROCEDURE.—After the parachute is laid out on the packing table and an even tension is applied, check the continuity of the suspension lines. The canopy is now whipped and folded identically to the man-carrying parachute canopy.

Attaching Break Cord.—To attach the break cord to the canopy bridle loop and the break cord attaching loop of the static line, proceed as follows:

Place the pack cover on the packing table near the canopy apex. Obtain a 24-inch length of 1/4-inch length of cotton tape. Three turns of 6 cord may be used if this tape is not available.

As shown in figure 5-29, pass one end of the break cord through the bridle loop. Place the two ends together and stretch the break cord taut. Pass each running end of the break cord through the attaching loop on the static line from opposite directions. Tighten the break cord so that the loop formed by the break cord is approximately 3 inches in length. Tie the ends together with a surgeon's knot and a square knot, then tie the ends around the break cord with 3 alternating half hitches.

Stowing Suspension Lines.—To stow the suspension lines, release the tension on the lines and canopy; then place the lift webs, spreader, and connector loops on the pack body.

Arrange the suspension lines the width of the pack body, with the first stow at lower left and the second stow at lower right. Secure the stows with the retainer rubberbands attached

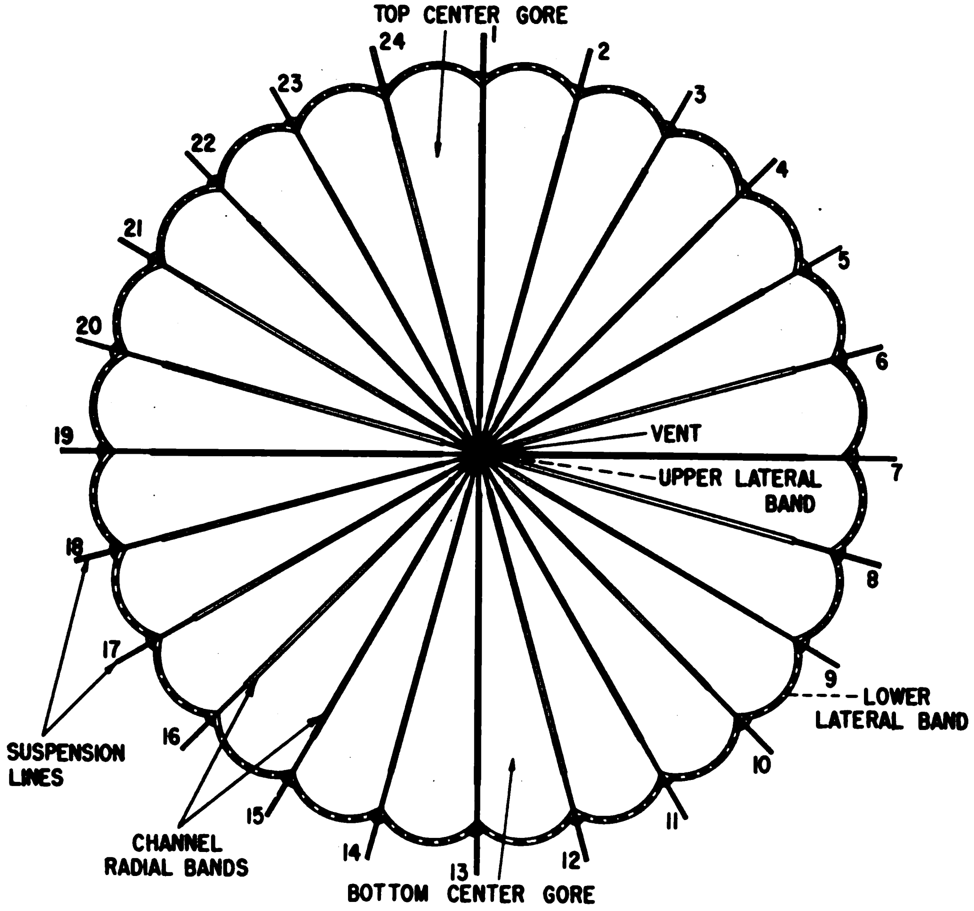


Figure 5-23.—G-1 and G-1A canopy laid out flat, top view.

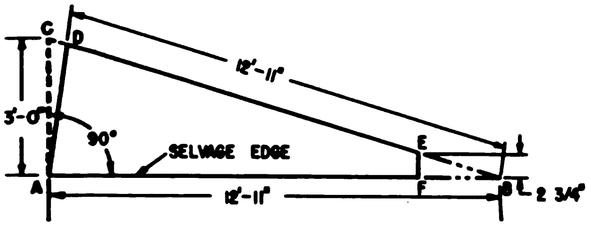


Figure 5-24.—Canopy gore dimensions, including seam allowance.

to the suspension line retainer band webs. (See fig. 5-30.) Continue this procedure until the suspension lines are stowed, leaving 12 to 14 inches of suspension lines between the last stow and the canopy skirt.

Packing Canopy.—To pack the canopy, unhook the bridle loop from the table and remove the shot bags. Pack the canopy on the pack body in the same manner as packing a man-carrying parachute, using accordion folds. The edges of the folded canopy are to be kept the same width and length as the pack body.

Closing Pack.—To close the pack, draw pack cover down over the folded canopy and pack body. As shown in figure 5-31, lace the pack body and pack cover loosely by passing two turns of 6 cord through opposite grommets of the pack body and pack cover sides. Tighten the lacing so that the pack cover fits snugly over the pack body, grommet over grommet, and tie the ends of 6 cord together with surgeon's knot and square knot.

Accordion fold the static line in folds approximately 12 inches long and hold with rubber retainer band. The G-1 cargo parachute assembly is now packed and ready for use as shown in figure 5-32.

G-1A PACKING PROCEDURE.—To whip and fold the canopy of the G-1A cargo parachute,

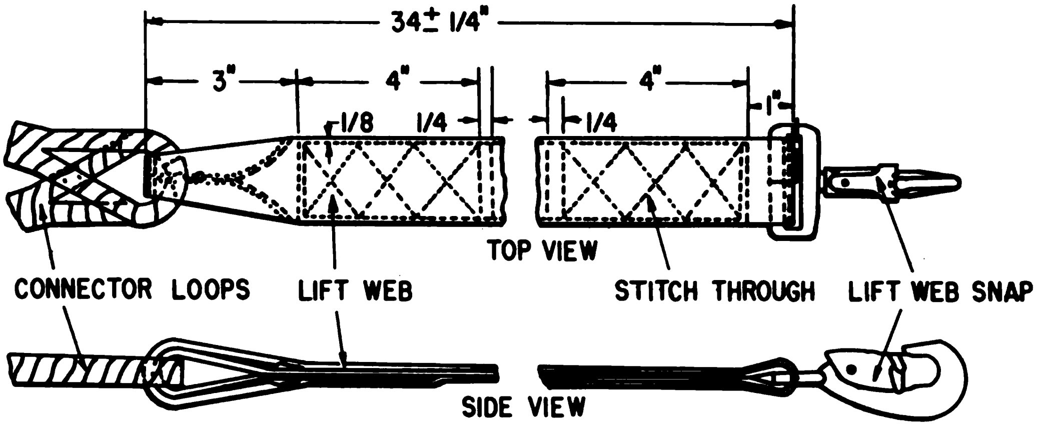


Figure 5-25.—Lift web, top and side views.

follow the same procedure as for the G-1 cargo parachute.

Attaching Break Cord.—To attach the break cord to the canopy bridle loop and the break cord attaching loop of the static line, proceed as follows:

Place the static line (separate unit) on table near the canopy apex. Using 1/4-inch tape or 6 cord, make a 3-inch loop, securing the bridle loop to the attaching loop in the same manner as attaching the break cord for the G-1 cargo parachute. (See fig. 5-33.)

Stowing Suspension Lines.—To stow the suspension lines in the pack, release the tension on suspension lines and canopy. Open the pack and roll down the side of the pack to aid in stowing of lines.

Place lift webs, spreader, and connector loops over the rubberbands attached to the suspension line retainers on the false bottom of the pack. Stow the suspension lines, following the procedure given for the G-1 cargo parachute.

Packing Canopy.—To pack the G-1A canopy, adapt the procedure for packing the G-1 canopy.

Closing Pack.—To close the pack, proceed as follows:

Fold cover flaps over the canopy, making certain that the static line emerges from the side of pack opposite the lift webs.

Take a length of 1/4-inch tape and insert one end through three cover loops on flaps, through the pack opening loop on the static line, and through the fourth cover loop (fig. 5-34). Draw the tape tight and tie the free ends of the tape together with a surgeon's knot and a square knot.

Fold the static line in accordion folds approximately 12 inches long. Stow on top of

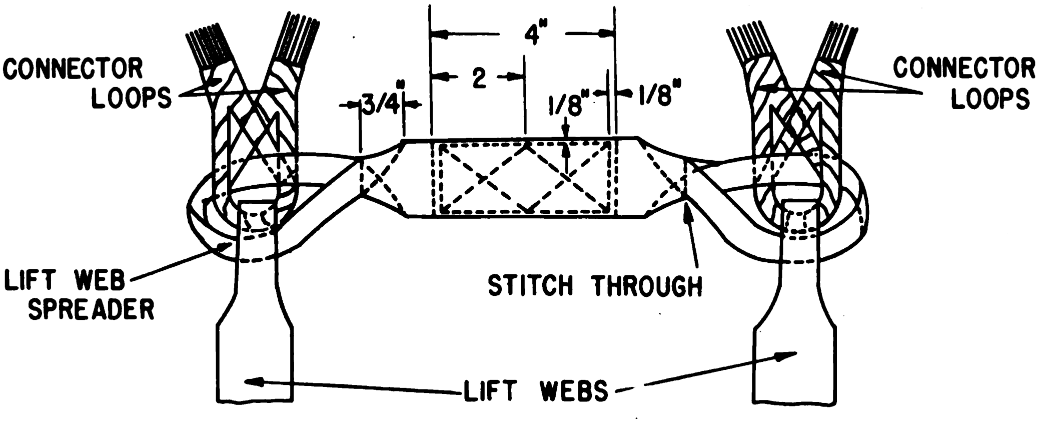


Figure 5-26.—Lift web spreader, showing method of securing to lift webs.

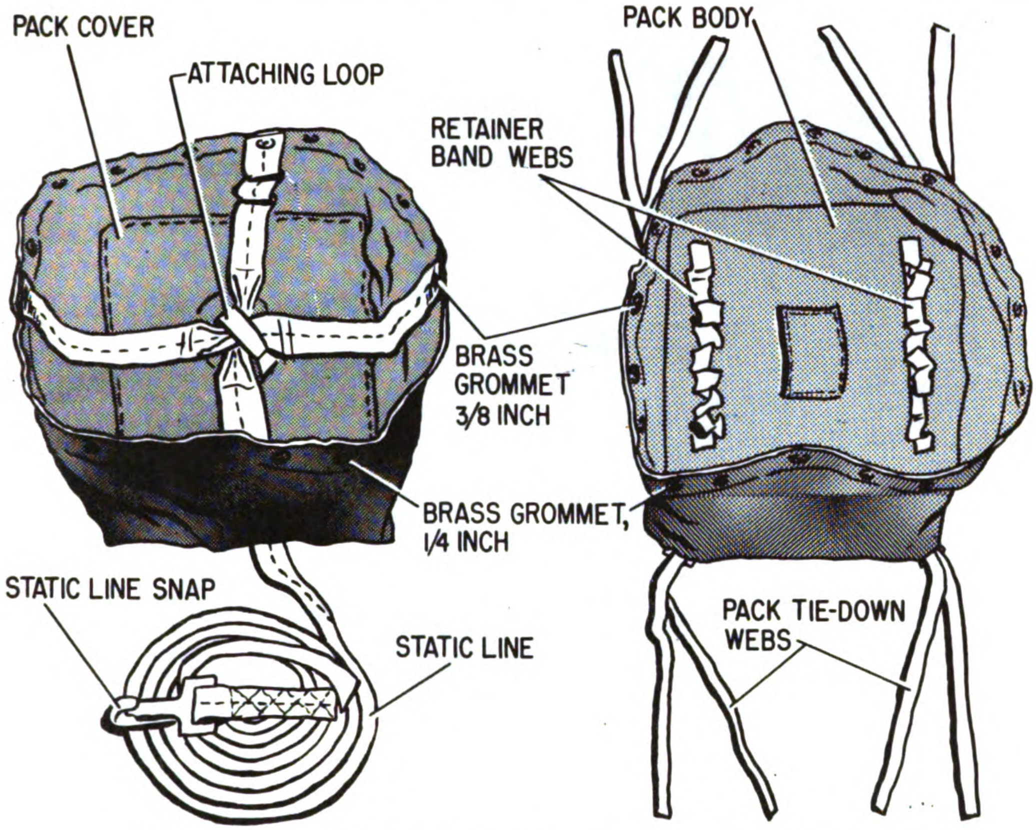


Figure 5-27.—G-1 pack body and cover, showing inside view.

pack, holding the stows with retainer rubberbands attached to the retainer webs. Figure 5-35 shows the G-1A cargo parachute packed and ready for use.

Containers (Type A-3 through A-10)

A-3 CONTAINER.—The type A-3 container consists of a 5-gallon capacity metal can. A canvas cover extends beyond the top of the can to form a holder for the parachute canopy.

The extension of the canvas cover beyond the bottom of the can provides a pocket for shock-absorbing landing pad. A pack cover is provided to fit over the parachute pack, and to this cover a static line is attached. The bottom of the canvas cover is closed by means of a 50-foot rope weighted with a 5-pound sandbag. This weighted rope uncoils during the drop but remains attached to the bottom of the unit for retrieving in the event of tree landings.

When the container is filled, the canvas cover is drawn completely over the can and the shock-absorbing pad is placed under the bottom.

Packing and Rigging.—Close the bottom of the canvas cover by lacing the free end of the 50-foot line through the grommets, drawing up tight, and securing with a bowline knot. The canopy is whipped and folded in the usual manner. Attach one group of lines to each of the 4 webbing loops. Lay the suspension lines in folds on the sewed-in canvas flap forming the bottom of the parachute pack portion of the canvas cover. The folded canopy is laid in accordion folds on top of the suspension lines.

Tie a 100-pound cord about 12 inches in length to the webbing loop inside the pack cover. Tie the free end of the pilot chute connector cord, from which the pilot chute has been removed, to the 100-pound cord loop, using a bowline knot.

Tie the loose end of the sandbag to the top webbing loop aligned with the D-rings on the outside of the container cover by passing a single turn of 6 cord through the grommet in the sandbag, through the webbing loop, and through the loop inside the pack cover. Tie the sandbag rope to the webbing at each end

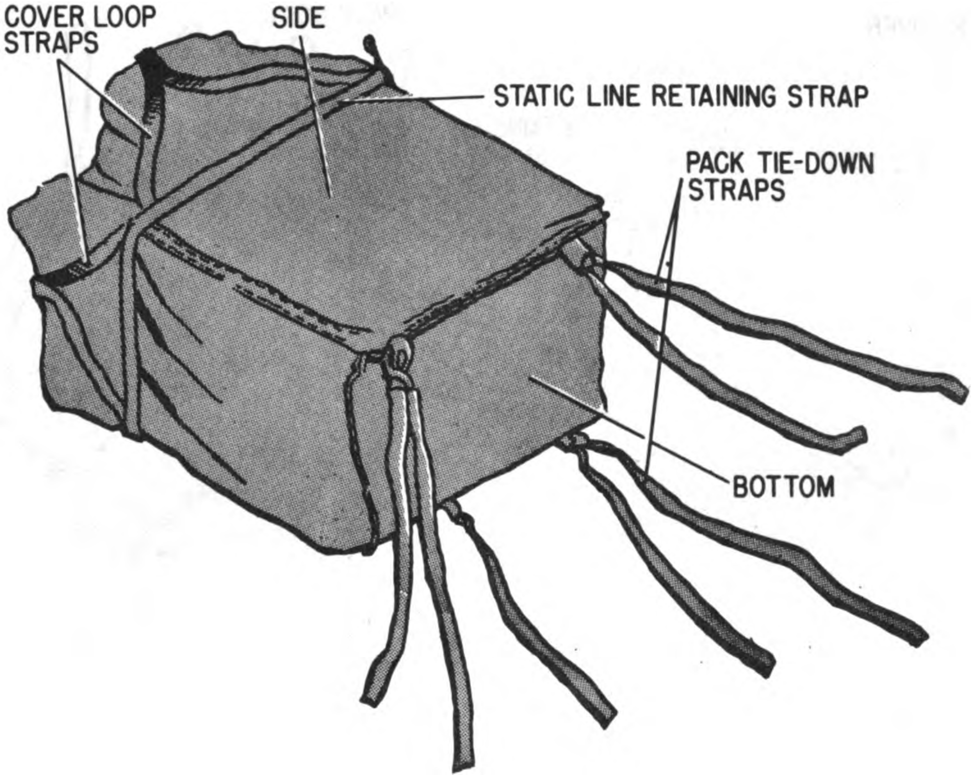


Figure 5-28.—G-1A pack, showing outside.

of the D-ring, using one turn of 6 cord. Coil the remainder of this rope and tie in the bottom of the assembly.

Pull the pack cover down over the assembly and fasten by threading one turn of 6 cord through the webbing loops on the pack cover and through the second row of webbing loops on the container cover.

A-4 CONTAINER.—The type A-4 container consists of an adjustable canvas container and a suspension harness made from webbing. The container is approximately 12 x 24 x 30 inches in size when fully loaded.

One end of the container is open for loading, and is closed by means of flaps laced together with cord. The other end is equipped with sets of tape for tying up excessive fabric after the container has been loaded. The top is equipped with webbing straps and V-rings for attachment of the parachute, and is reinforced with a steel frame containing two steel loops for engaging the bomb shackle. The bottom is reinforced with plywood. The container is furnished with two corrugated fiber boxes. It may be used with or without the boxes.

Packing and Rigging.—When the container is packed with supplies, the weight of the contents should not exceed 200 pounds.

Figure 5-36 illustrates the construction of the A-4 container. There are two sets of connections on the top; one pair of steel loops for engaging the bomb shackle, and a pair of web straps with V-rings for attachment of the parachute.

When the container is loaded, the open end is closed by lacing with the 6-foot length of braided cord furnished with the container. Tighten the excess fabric by tying the pairs of webbing tapes together at the other end of the container. The parachute assembly is tied to the end of the container, and the tie-tapes of the parachute pack are passed around the container harness webbing.

Snap the lift webs of the parachute to the V-rings on the web straps at the top of the container. To prevent the lift webs from pulling out of the pack under slipstream pressure, tack the webbing to the pack.

A-5 CONTAINER.—The type A-5 container consists of a heavy sheet of canvas 15 feet long

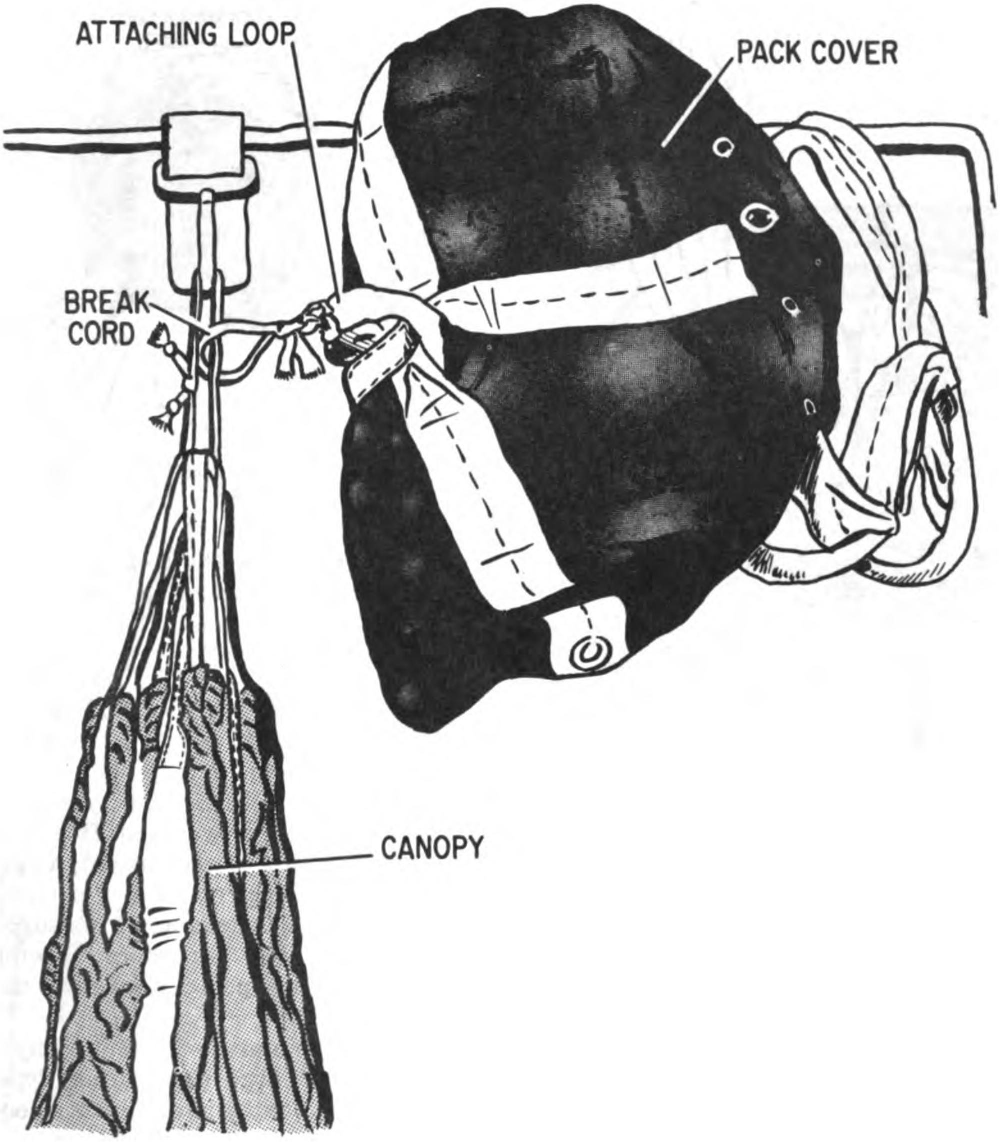


Figure 5-29.—Break cord attached to bridle loop and attaching loop.

by 56 inches wide, with a pad of felt 40 inches wide running down the center. The canvas edges fold inward over the load, and the unit is rolled into a roll about 18 inches in diameter over which removable end flaps are fitted. It is used in conjunction with the standard aerial delivery parachutes, types G-1 and G-1A. The type A-5 container was developed for the aerial delivery of rifles and similar equipment and supplies.

Packing and Rigging.—Place the container roll flat, with the rifles placed about 12 inches apart down the center with the butts alternating. The container will accommodate about 12 Model M-1 rifles to a roll. The spaces between the rifles are filled with ammunition.

Fold the canvas flaps at the outer edges over the ends of the rifles and roll the container about the equipment to make a compact roll. Draw the end caps over the ends of the roll and secure by fastening the adjustable webbing together, using bayonet fittings or snaphooks. Tighten the webbing to suit the load.

Attach the parachute to either end of the container by tying the tapes on the corners of the pack to the tabs on the end of the container cap.

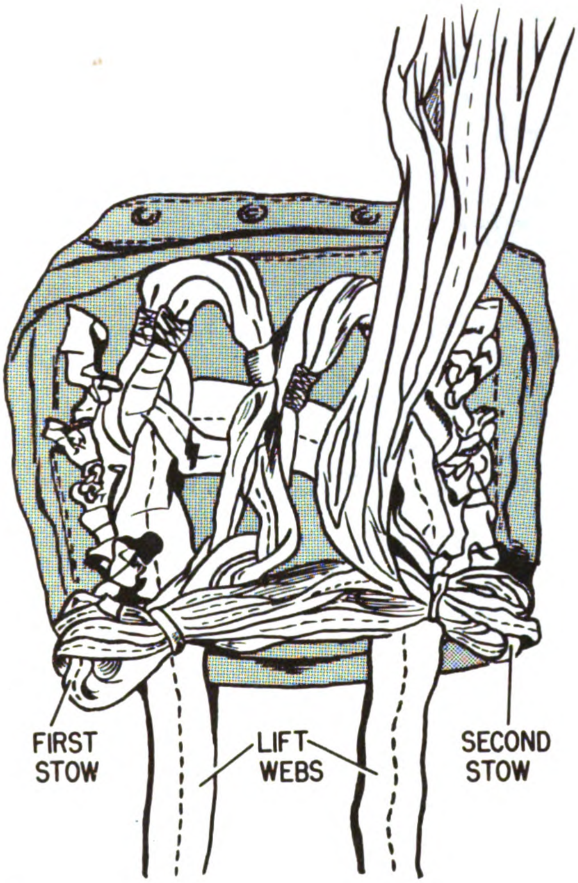


Figure 5-30.—Suspension lines, showing first and second stows.

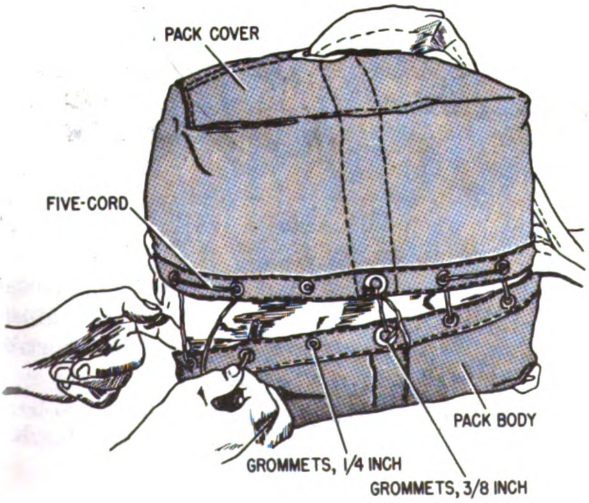


Figure 5-31.—Closing the G-1 pack, showing cover being laced loosely to the body.

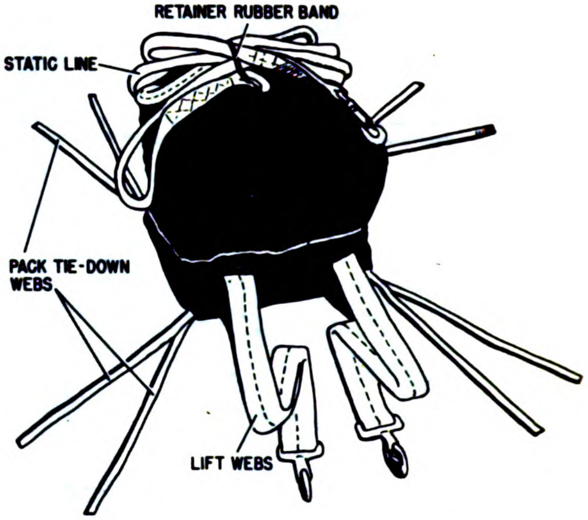


Figure 5-32.—The G-1 cargo parachute assembly, packed and ready for use.

Hook the lift webs of the parachute to the V-rings and tack the webs to the edge of the end cap.

A-6 CONTAINER.—The type A-6 container consists of a corrugated fiber carton, into which the contents are packed; a canvas cover, fitting over and protecting the carton; a webbing sling or harness, for suspending the container to the parachute assembly; and a shock-absorbing pad, attached to the bottom of the container.

This container is used in conjunction with the standard cargo parachutes, types G-1 and G-1A, for the delivery of miscellaneous supplies and equipment. The dimensions of the corrugated fiber carton are 12 x 12 x 30 inches. Figure 5-37 shows three plastic waterbags packed in the A-6 container.

A-7 CONTAINER.—The type A-7 container consists of an adjustable webbing sling developed specifically for use in delivering 30-, 45-, and 50-caliber arms and 37-mm ammunition. However, since this sling is adjustable, it can be adapted readily for the delivery of other supplies, including standard 5-gallon cans of water or gasoline, as shown in figure 5-38. The type A-7 container is also used with the G-1 and G-1A parachutes.

Packing and Rigging.—The webbing sling is strapped around the standard ammunition box, or other load, with the V-ring on top. When the

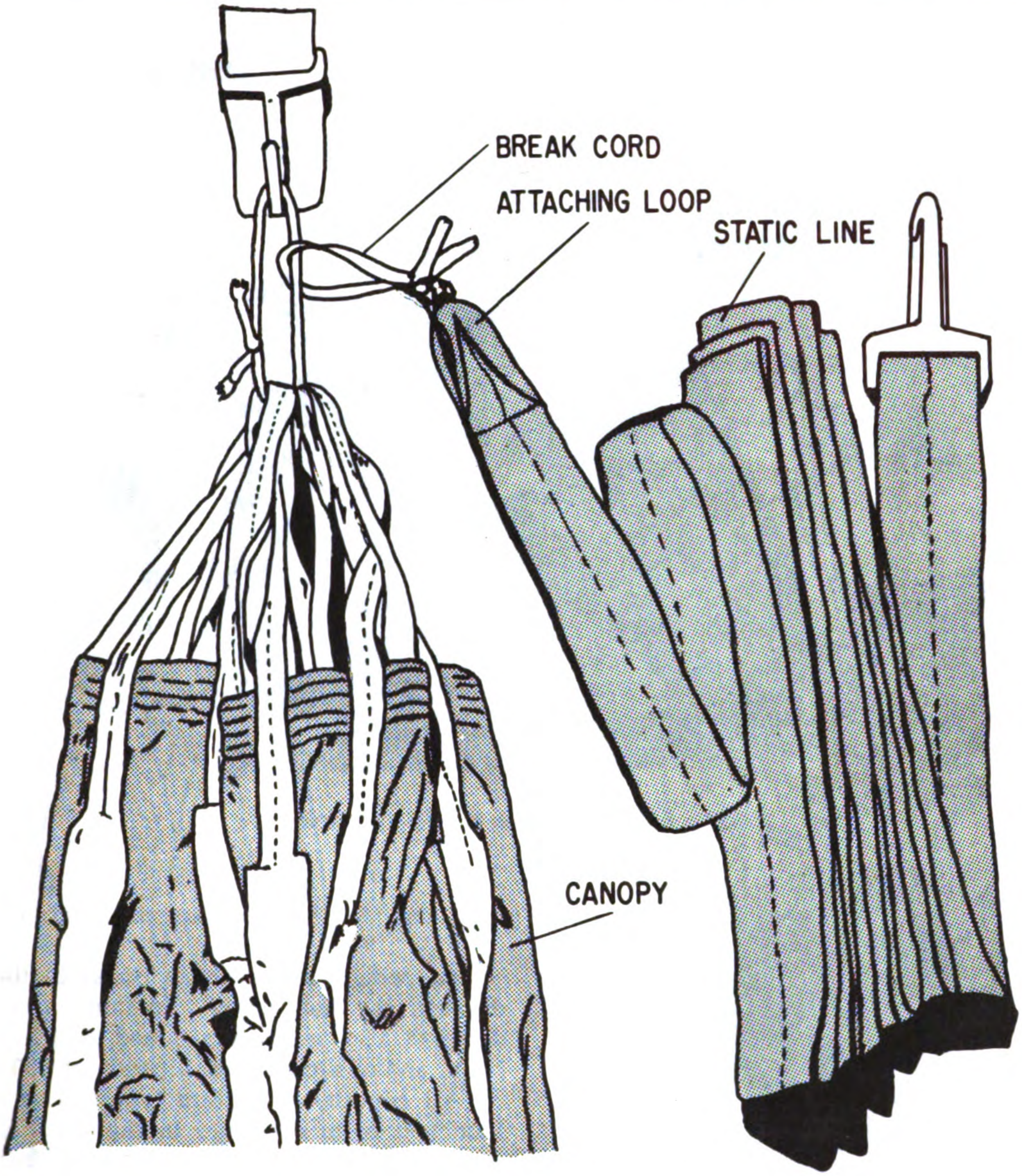


Figure 5-33.—G-1A break cord attached to bridle loop and attaching loop.

sling is used with three 5-gallon cans, padding should be inserted between the cans.

Attach the parachute assembly on either side of the load by tying the tapes on the pack corners to the webbings on top and bottom of the load. Hook the liftwebs of the parachute to the V-rings on top of the sling.

A-8 CONTAINER.—The A-8 container consists of a rigid, octagon-shaped, collapsible container constructed of reinforced fiberboard. The container is 50 inches long and 18 inches in diameter. It is intended for delivery of rifles, and is used with the types G-1 and G-1A parachutes.

A-9 CONTAINER.—The type A-9 container consists of an adjustable webbing sling developed for the aerial delivery of 60-, 75-, and 81-mm fiber ammunition cases, and is used in conjunction with the standard types G-1 and G-1A cargo parachutes.

A-10 CONTAINER.—The type A-10 container consists of a cargo net approximately 9 feet

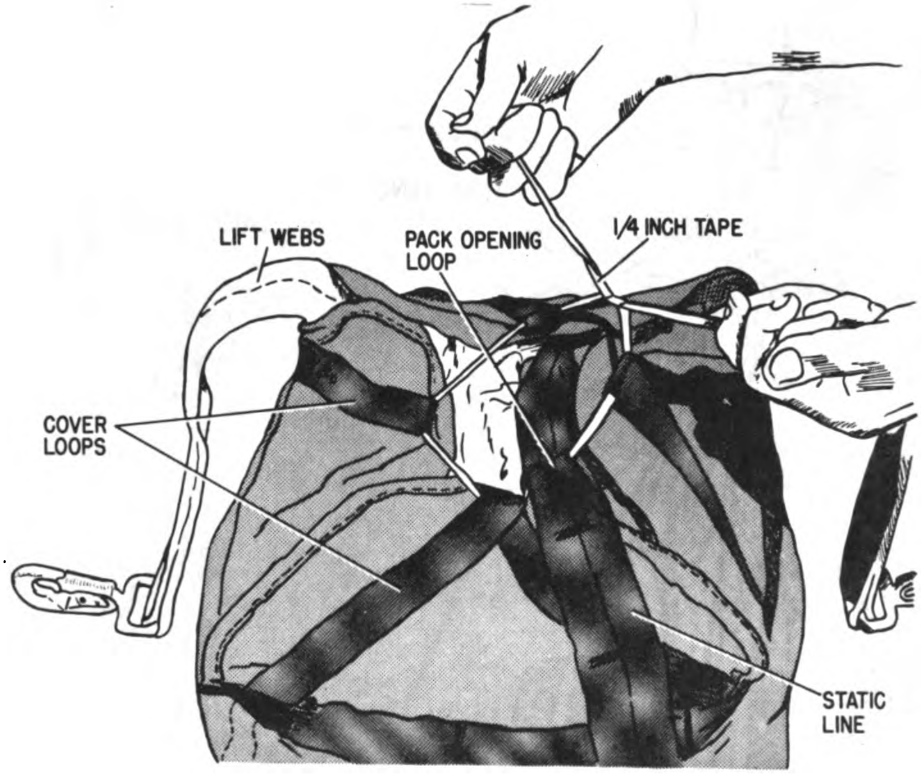


Figure 5-34.—Closing the G-1A pack.

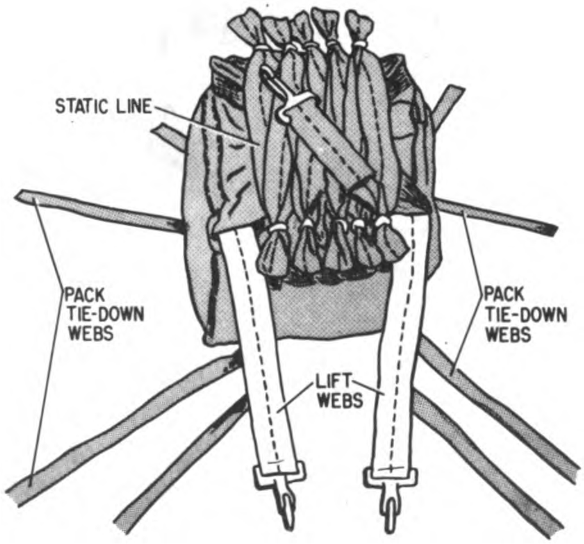


Figure 5-35.—G-1A cargo parachute, packed and ready for use.

square. It is intended for delivery of miscellaneous equipment of suitable size and is also used with the types G-1 and G-1A parachutes.

Launching Instructions and Restrictions

To reduce as much as possible the risk of damage to the loads, containers should be dropped at a maximum speed of 150 miles per hour, and at a minimum altitude of 300 feet.

All containers of this type can be manually launched from openings in the aircraft. When they are launched from openings in the aircraft, the entire 15 feet of static line is utilized.

All containers, with the exception of types A-7 and A-10, can be launched from internal or external bomb racks. When they are launched from internal bomb racks, the full 15 feet of the static line is used. When launching from external bomb racks, the static line is shortened to 10 feet by winding the line around the bomb shackle attachment so that it does not interfere with the launching mechanism.

Containers, types A-5 and A-9, are equipped with D-rings for engaging bomb shackles. These containers can be launched from bomb racks when the dimensions of the load are such that these D-rings are spaced to fit standard bomb

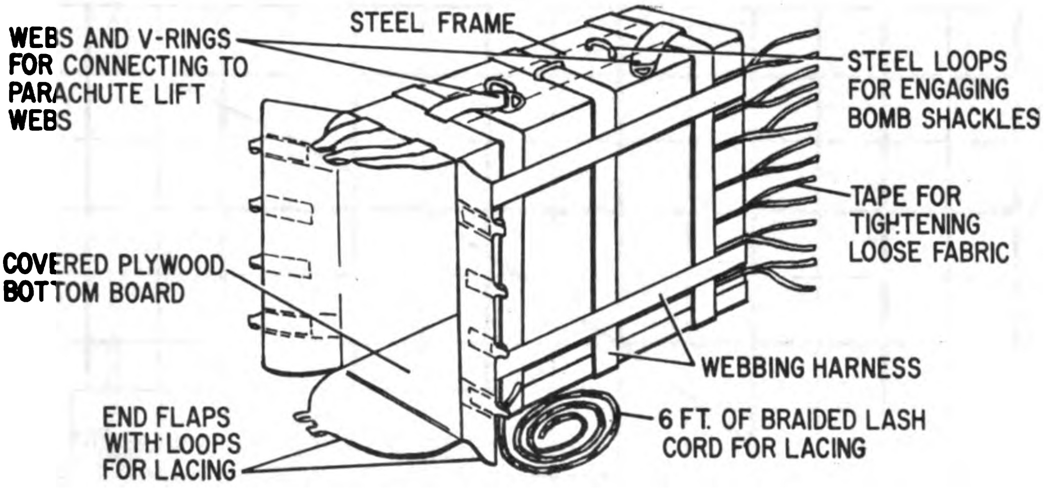

WEBS AND V-RINGS FOR CONNECTING TO PARACHUTE LIFT WEBS
STEEL FRAME
STEEL LOOPS FOR ENGAGING BOMB SHACKLES
TAPE FOR TIGHTENING LOOSE FABRIC
COVERED PLYWOOD BOTTOM BOARD
WEBBING HARNESS
END FLAPS WITH LOOPS FOR LACING
6 FT. OF BRAIDED LASH CORD FOR LACING

Figure 5-36.—Type A-4 container assembly.

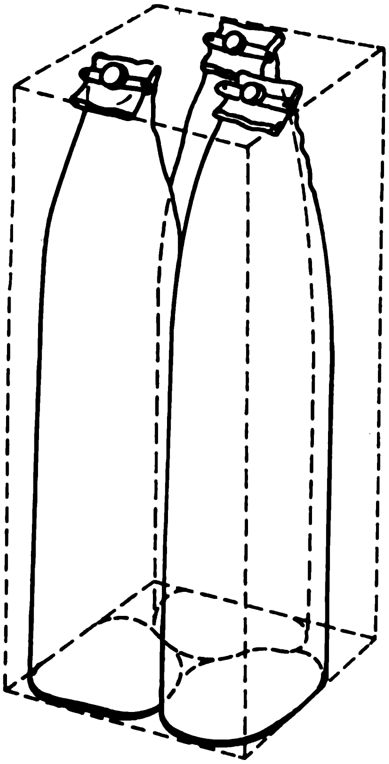


Figure 5-37.—Three plastic waterbags packed in the A-6 container.

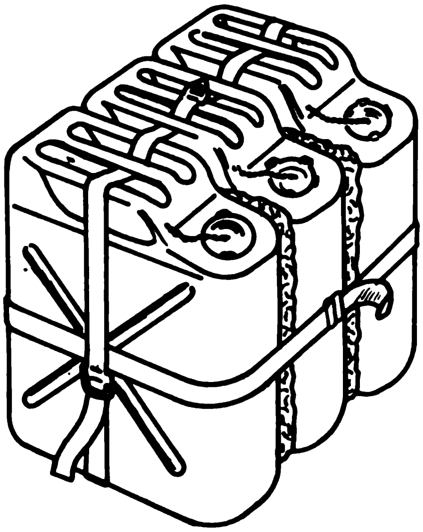


Figure 5-38.—The A-7 adjustable sling adapted to three 5-gallon cans.

shackles. It is absolutely essential that the free end of the static line be attached to some structural member of the aircraft.

The rates of descent of the standard cargo parachutes, types G-1 and G-1A, are illustrated on the graph shown in figure 5-39.

Types G-11 and G-11A

The G-11 and G-11A cargo parachutes are used for heavy drop aerial delivery. The two parachutes differ only in minor details, and the procedures for handling are essentially the same.

The G-11A canopy assembly is flat, circular in shape, and is 100 feet in diameter. It is divided into 120 gores, each gore being constructed of 13 panels. The canopy has 60 suspension lines. For packing purposes, the suspension lines are considered as ending at the

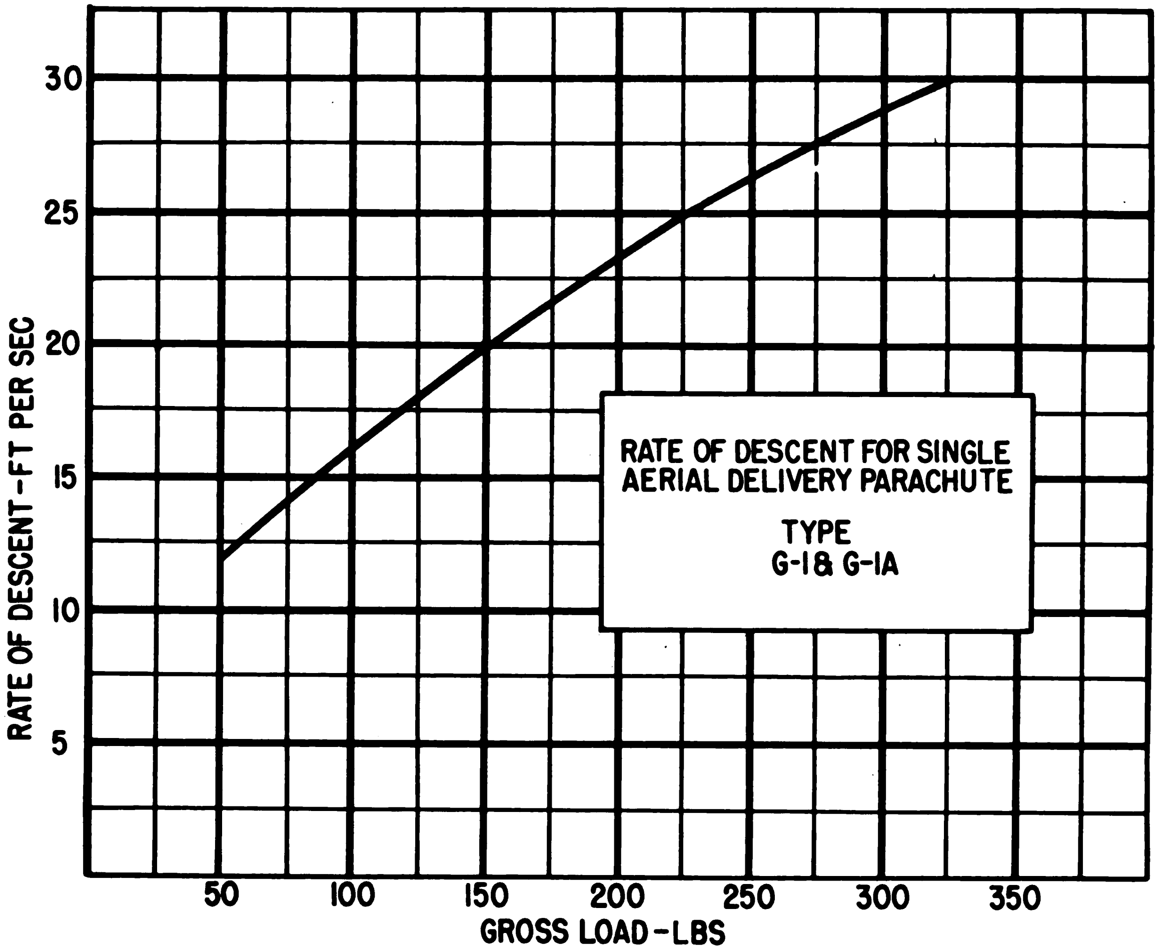


Figure 5-39.—Rates of descent for single cargo parachutes.

skirt. They are numbered from 1 to 120, counterclockwise, when facing the skirt from the connector links.

INSPECTION.—The G-11 and G-11A parachutes are visually inspected every 60 days, or more often if conditions warrant such inspection. The condition of the canopy, suspension lines, webbings, and pack should be checked for tears, excessive moisture, mildew, and stains.

LAYOUT.—A working space approximately 155 feet long is required for packing operations, provided tension is applied at the clevis loops of the riser. (See fig. 5-40.) If a packing surface of this length is not available, tension may be applied at the connector links. In this case, a surface approximately 85 feet long is sufficient. If packing tables of this length are not available, a suitable area may be prepared from a smooth section of concrete floor where the surface can be painted to eliminate the normal abrasive action of concrete. This method of packing is recommended only where packing tables are not adequate.

PACKING.—Because of the extreme large size and the limited use of the G-11 and G-11A cargo parachutes by the Navy, the packing procedures are not covered here. For the step-by-step procedure, reference should be made to the applicable maintenance and packing manual.

Heavy Drop Parachute Release Assemblies

JAW TYPE.—The jaw type parachute release assembly consists of a body assembly, two release spring assemblies, two suspension slings, and two cutters.

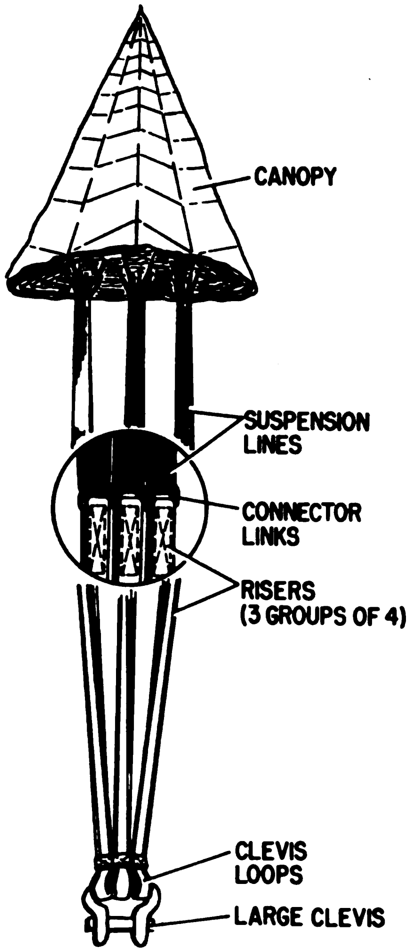


Figure 5-40.—Layout of G-11 and G-11A parachutes.

Body Assembly.—The steel body assembly consists of a left- and right-hand body held together by a steel shaft. The bodies are keyed to the shaft and held in place by flat washers and locking nuts, or split washers and conventional nuts. The mouth of the body assembly provides a seat for the suspension pin, and side plates cover the open ends to prevent the suspension pin from sliding out. The jaws, which provide recesses for the cutters, are held to the lower end of the bodies by hinge pins.

Release Spring Assemblies.—Two release spring assemblies are screwed into the body assembly behind the suspension pin seat. Each assembly consists of a housing which holds the assembly, a plunger which pushes against the suspension pin, a spring which applies tension on the plunger, an adjusting screw which regulates the tension, and a cap which covers the open end of the housing. Two types of springs, lightweight and heavyweight, are issued with the release assembly. The light springs (bronze color) are used with loads requiring one 100-foot parachute; the heavy springs (silver or black color) are used with loads requiring two 100-foot parachutes.

Suspension Slings.—Two 2-foot suspension slings are used with the release assembly. A permanent 2-foot sling is fixed at one end to the shaft of the release assembly and at the other end to the clevis assembly on the parachute risers or parachute riser extensions. The second 2-foot suspension sling is fixed at one end to the large clevis assembly on the load suspension slings and at the other end to the suspension pin which fits into the mouth of the assembly.

Cutters.—Two reefing-line cutters (fig. 5-41) are used with each release assembly. The cutters are inserted through the jaws and upper recesses of the body assembly and are tied in place with silk, cord, or authorized substitute material, inserted through the holes in the upper recesses and the cutters.

In operation (fig. 5-42), the firing wire is pulled out by the deploying parachute, and the firing plunger locking ball is pushed down into its recess by the firing plunger. The firing plunger, under spring tension, travels forward until the firing pin strikes the percussion cap. The cap then fires the charge through the fuse chamber; and after 10 seconds, the fuse fires the charge in the activating chamber. The activating charge then pushes the cutter blade forward, shearing the silk cord which passes through the holes on the cutter.

Operation.—An understanding of the operation of the release assembly will aid the Parachute Rigger in properly preparing, installing, and adjusting the assembly. Generally, the operation of the release assembly follows the order shown in figure 5-42 (A), (B), (C), and (D).

As shown in view (A), when the main cargo canopy starts to deploy, it pulls on the large clevis assembly which connects the parachute risers to the permanent 2-foot sling on the release assembly. The clevis assembly, which is tied to the firing wires in the two reefing-line cutters, pulls out the wires and activates the cutters.

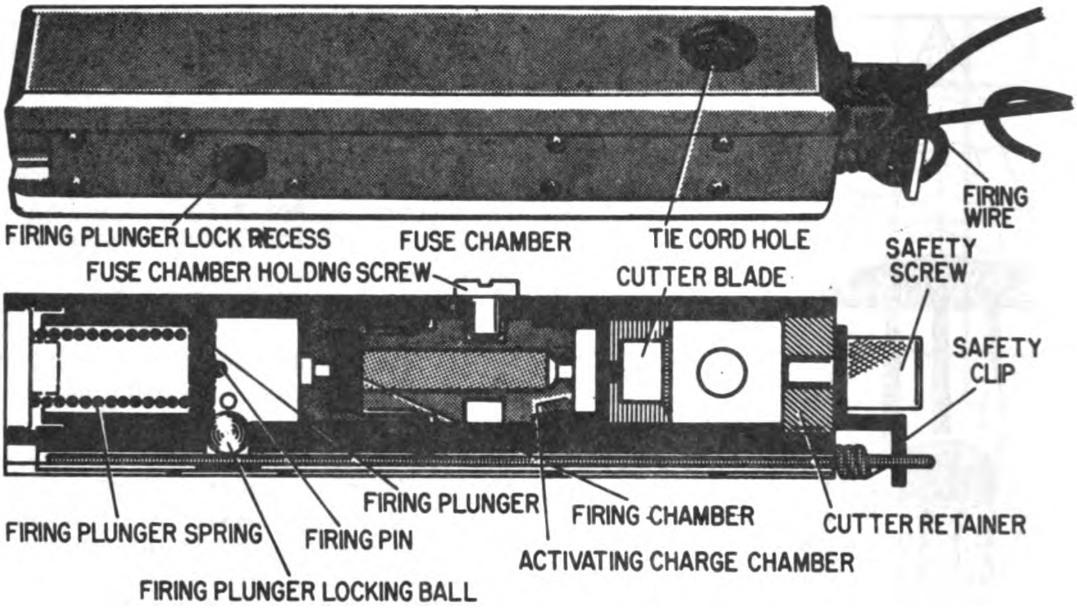


Figure 5-41.—Reefing line cutters.

In the 10 seconds that elapse between the pulling of the firing wires and the firing of the cutters, the load receives the opening shock of the main cargo parachute, rebounds slightly, and settles again with its weight pulling on the suspension pin in the mouth of the release assembly.

The cutters fire and cut the suspension line that holds the cutters in the release assembly. After the cord has been cut, the cutters are free to drop out of the recesses in the top of the body assemblies, as shown in view (B).

After the cutters have fallen out, the jaws pivot open, as shown in view (C): The suspension pin remains seated in the mouth of the release assembly as long as the weight of the load pulls on the 2-foot suspension sling, thus overcoming the tension on the release springs behind the suspension pin.

As the load strikes the ground, the suspension pin is relieved of the weight which holds it in the assembly. The release plungers, under spring tension, push the suspension pin out of the mouth of the release assembly, as shown in view (D). The load is then freed from the parachutes, preventing the parachutes from dragging or upsetting the load.

FINGER TYPE.—The finger type, or multifinger, release assembly consists of a steel body with two body plates, release lever, release arm link, and a release arm. Pivoted on hinge pins at the edge of the body are the large and small cutter retainers.

The suspension finger slings used with the multifinger release assembly are constructed of six plies of nylon webbing. To permit the close fitting of release fingers over the release arm of the body assembly, as shown in figure 5-43, the slings are issued in two different lengths. The fingers pivot on hinge pins on the finger links.

One reefing-line cutter is used with the multifinger release assembly. The cutter is inserted through the large and small cutter retainers of the body. The operation of the cutter is on the same principle as the operation of the cutters used on the jaw type release.

Two types of springs may also be used with the finger type release assembly. Lightweight or heavyweight may be used, and the weight of the load being used with the release assembly determines whether a light or heavy spring will be used and whether the spring is placed at the No. 1 or No. 2 force point of the release lever.

Operation.—As the main cargo parachute deploys, the riser extension of one parachute breaks the safety cord holding the riser link to the release arm, then pulls the firing wire out of the time cutter.

In the 10 seconds that elapse between the pulling of the firing wire and the firing of the

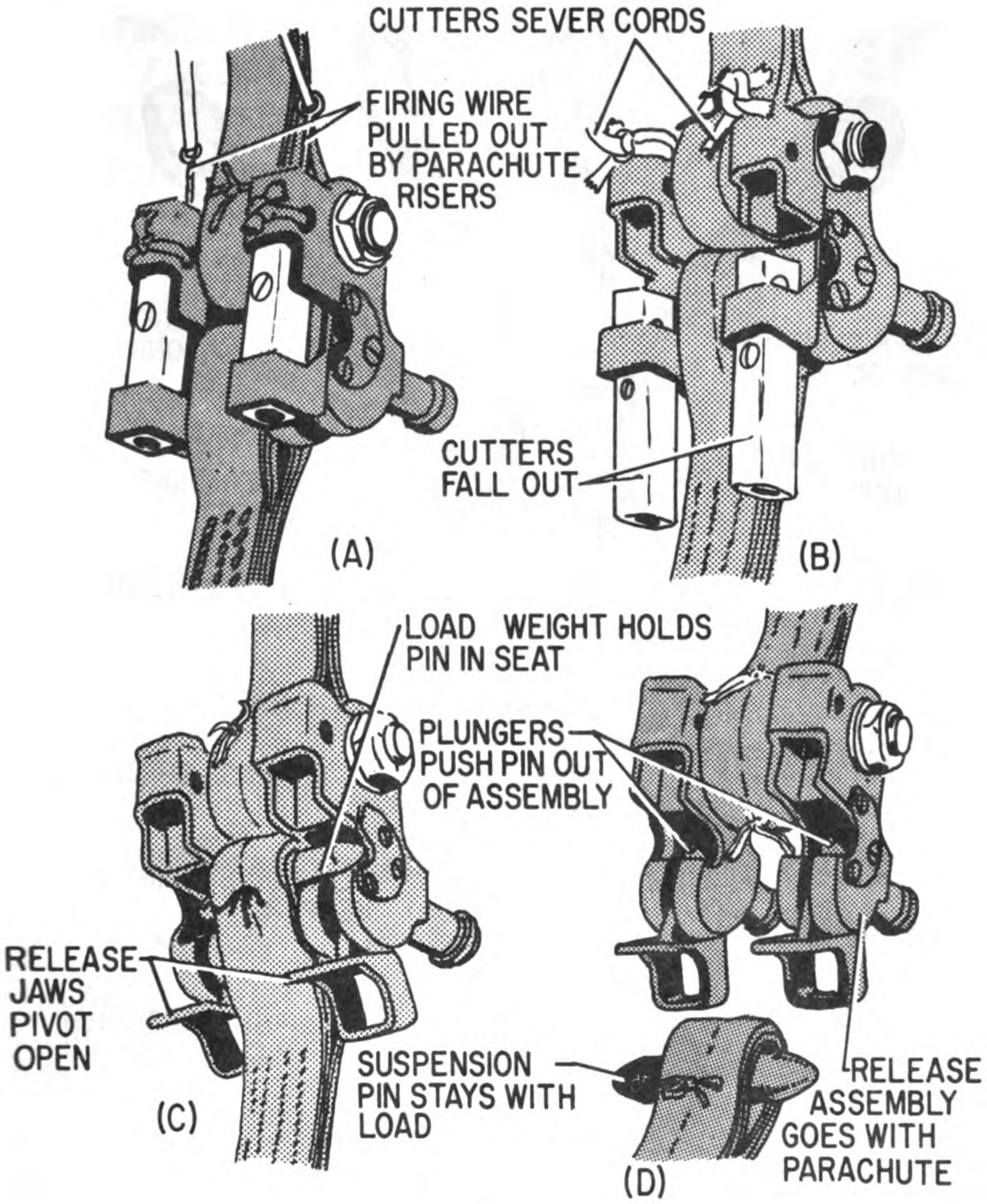

CUTTERS SEVER CORDS
FIRING WIRE PULLED OUT BY PARACHUTE RISERS
CUTTERS FALL OUT
(A)
(B)
LOAD WEIGHT HOLDS PIN IN SEAT
PLUNGERS PUSH PIN OUT OF ASSEMBLY
RELEASE JAWS PIVOT OPEN
SUSPENSION PIN STAYS WITH LOAD
RELEASE ASSEMBLY GOES WITH PARACHUTE
(C)
(D)

Figure 5-42.—Operation of release assembly.

utter, the load receives the opening shock of he main cargo parachutes. Then the load reounds slightly, and settles again with its eight pulling against the release arm link, olding the link stud in the body plates.

The cutter fires and cuts the suspension line asing that holds the cutter in the retainers. After the line has been cut, the cutter is forced out of the small cutter retainer by the cutter ejecting spring and rotates in the lower cutting retainer.

After the cutter has fallen out, the release arm link is free to pivot outward, but as long

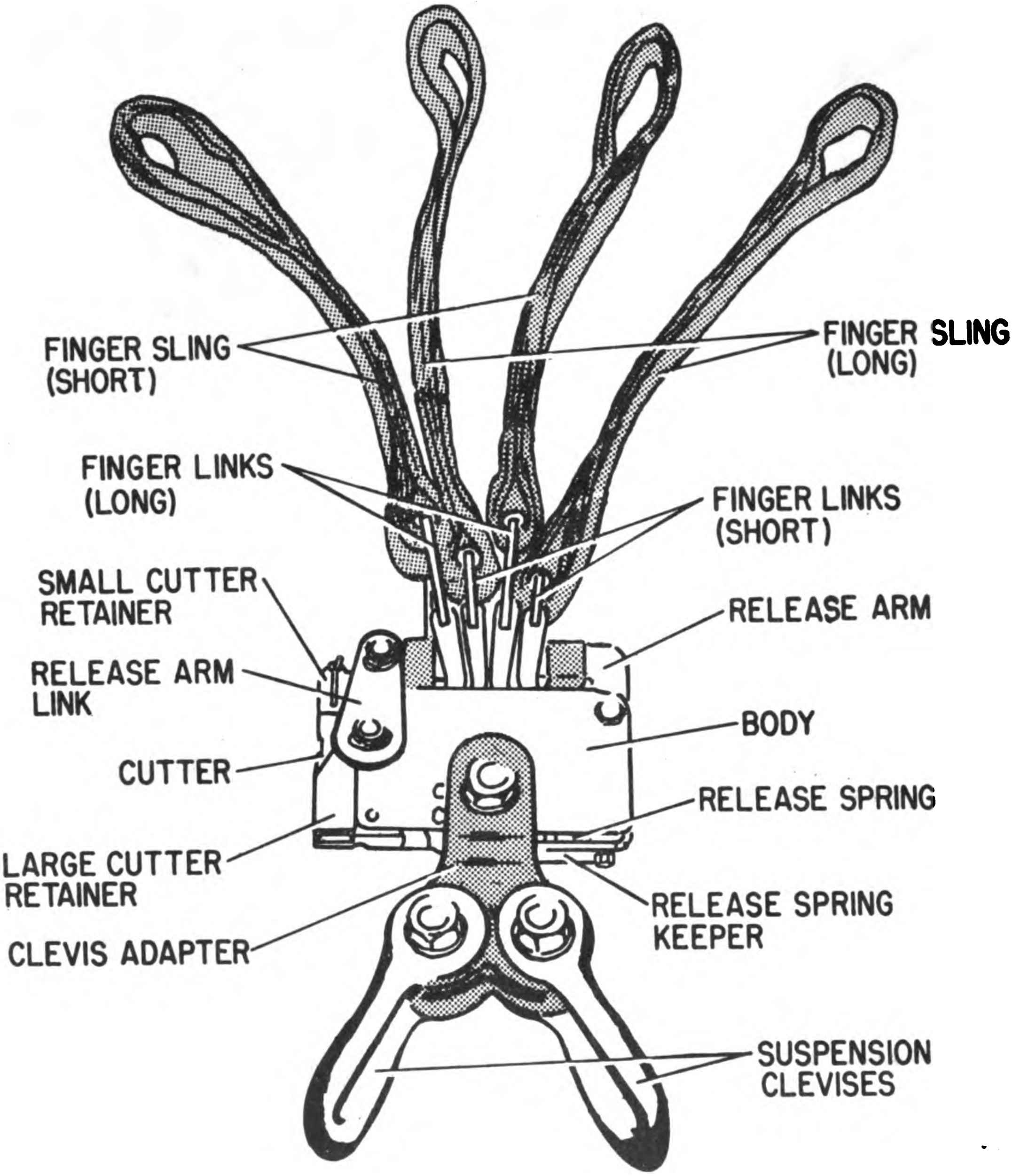


Figure 5-43.—Finger type (multifinger) release.

as the weight of the load pulls against the assembly, the link stud will be held in the notch in the body plate.

As the load strikes the ground, the release arm link is relieved of the weight which holds it in the assembly. The release lever, under spring tension between the body plates, is thus able to pivot upward, pushing the link stud out of the notch in the body plates.

The drag of the parachutes then pulls the release arm upward (fig. 5-44) until the fingers, which are hooked around the release arm, clear the slot that holds the fingers closed between the body plates. As soon as the fingers are clear, they spread open, freeing each parachute separately from the load, thus preventing the parachutes from dragging or upsetting the load.

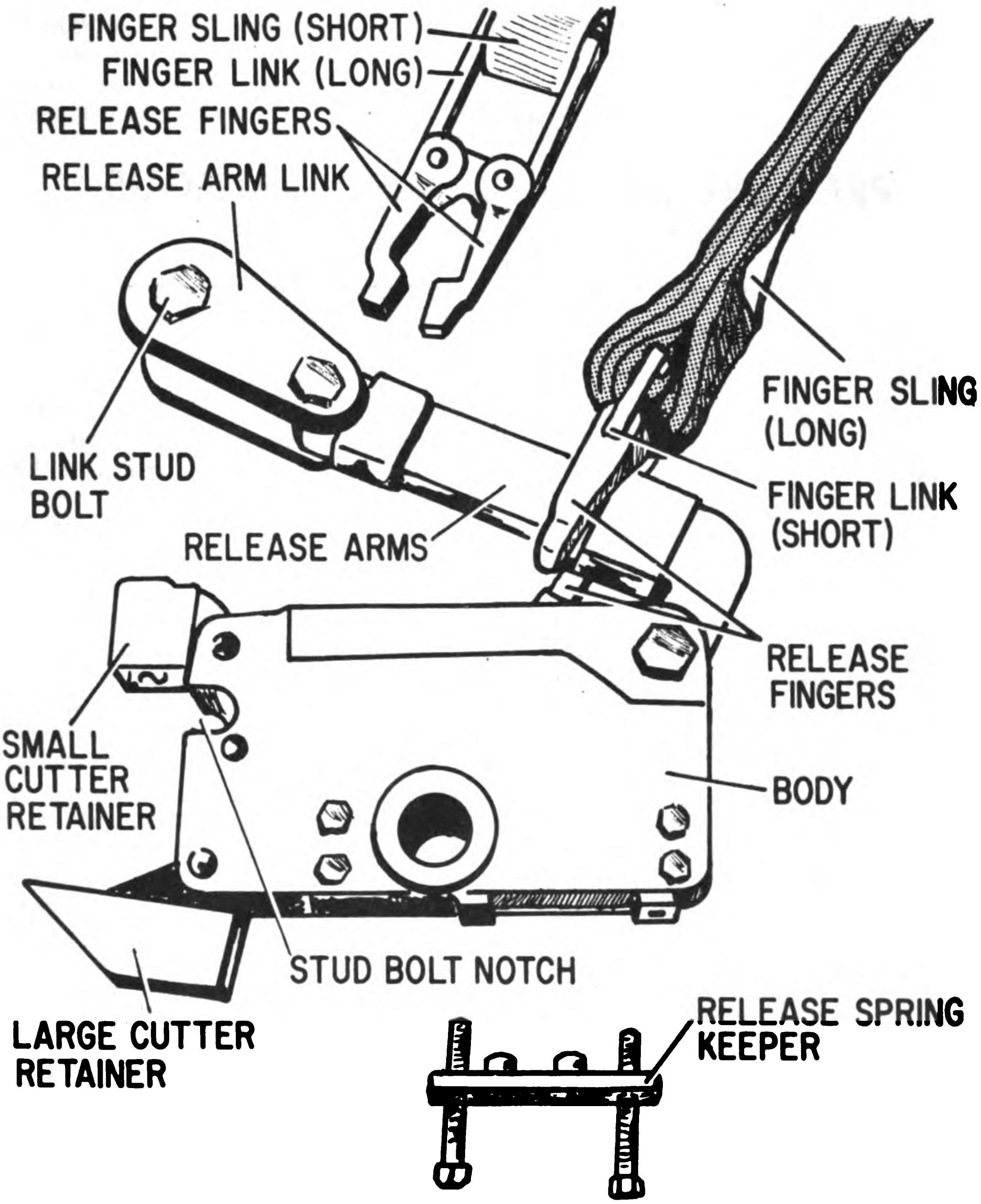


Figure 5-44.—Operation of finger type release assembly.

CHAPTER 6

PRESSURE SUITS AND MISCELLANEOUS PERSONAL EQUIPMENT

INTRODUCTION TO PRESSURE SUITS

James Sullivan and his associates at the U.S. Navy's Institute for Aviation Medicine at Philadelphia spent years devising the first reliable pressure suit. When we think of pressure suits we must free our minds of the idea of a diving suit. The pressure suit consists neither of a simple rubber skin nor of rigid, strong armor. The heavy armor of the deep sea diver is of no value in airless space because the suit need not withstand the pressure of hundreds of atmospheres, but only the internal pressure of one atmosphere. This internal pressure, of course, tends to blow up the suit like a balloon. In the first experimental models, the arms and legs of the rubber skin puffed up stiffly under the internal pressure, making the subjects immobile and helpless.

The development of the Navy full pressure suit is said to have cost some $300,000. These fantastic looking suits are therefore one of the costliest "garments" in the world. But they are worth it, for they are supposed to allow the wearer almost complete mobility. Semi-rigid accordian pleats permit shoulders, elbows, and knees to move freely. Clever airtight joints permit wrists, ankles, hands, and feet to turn. The well-protected fingers have as much play as they would have in heavy gloves. The helmet, a globular, transparent plastic bell, is attached to the shoulders of the space armor, and special zippers provide an airtight closure for the entire suit.

This pressure suit is still one of the most secret clothing items in the world. Thousands of tests in pressure chambers helped the designers check on ingenious ideas and improve innumerable details. In order to meet practical requirements, the suit had to be manufactured in three sizes. Attired in them, human subjects performed hard work in simulated aircraft and rocket plane cabins to measure the physical strain of wearing the suits. The final step was assembly line production of the suits. They are said to cost about $2,000 apiece. In some not distant future, in the limitless realms beyond the earth's atmosphere, worlds away from man's natural living space, they will have to prove their worth.

One of the earliest pressurized garments was the T-1 partial pressure suit, developed by the USAF. Briefly, the T-1 partial pressure suit was a made-to-measure overall garment not covering the hands, feet or head, and was used with the K-1 pressure helmet. When the aircraft ascended above the 45,000-foot level and cabin pressure was lost, the suit controller was activated and tubes running down the body sides and arms and legs were inflated. This in turn shortened the capstan lacing around these portions of the body, thereby applying a mechanical pressure to compensate for the lack of barometric pressure. The helmet also became pressurized by oxygen, and breathing was performed against a positive pressure very much like the A-13A pressure breathing mask.

The suit, when pressurized was extremely uncomfortable and offered no protection for the hands and feet. By the end of 10 to 15 minutes in the pressurized condition it was difficult to remain in the suit. But it did serve its purpose as an emergency garment and offered enough protection for about 10 to 15 minutes so that a descent could be made to a safe altitude. This meant of course that once the cabin pressure was lost the pilot had to descend to a safe altitude and the mission probably aborted. It also put a limit on altitude, for if it took longer than 10 minutes to get from operational altitude to a safe altitude the partial pressure suit lost its value. Later USAF partial pressure suits such as the MC-3 and MC-4, which used chest breathing bladders and redesigned helmets, resulted in more comfortable suits with greater time-altitude capabilities.

Above 63,000 feet we faced still another barrier to human life, because at this height, atmospheric pressure drops so low that it can no longer prevent boiling of the blood in the body. If boiling occurs, serious disturbances and possibly irreparable damages must be anticipated.

There are two ways in which a liquid can be caused to boil. One way is to heat the liquid until its temperature reaches the boiling point. By raising the temperature of a pot of water, we increase the pressure of the water vapor on the surface. It is only in the surface that vapor can issue from liquid and escape into the air. No bubbles of vapor can form in the liquid itself before the boiling point is reached. The whole body of water stands under the same pressure as the air that rests on its surface. At lower temperatures the pressure of the water vapor is too small for the formation of vapor bubbles in the liquid.

As soon as the water reaches a temperature of 212°F., the pressure of the water vapor becomes equal to the barometric pressure. Then the water can be changed to vapor in the liquid itself; the vapor swells up in numerous bubbles that develop enough tension to work against the pressure of the liquid. The bubbles, being lighter than the liquid, float upward, burst at the surface and discharge their contents of steam into the air, thus the water boils. Therefore, one can see that if the barometric pressure is lowered the temperature that causes boiling is lowered.

Atop Mt. Whitney where the barometric pressure is only 60 percent of its value at sea level, water starts boiling at 185° F. The human body and blood has a temperature of 98.6° F. Therefore, the blood and body fluids will start to boil at an elevation where the barometric pressure of the air has dropped to a point that will allow blood and body fluids to vaporize at a temperature of 98.6° F. This critical mark is 63,000 feet above the surface of the earth were barometric pressure is less than 1 p.s.i. The boiling of body fluids at an elevation of about 12 miles marks a further functional border of space. Beyond this border the protection of an individual against loss of artificial pressure becomes a vital necessity, less he suffer a quick, blood boiling death.

Basically all this left us with the fact that men flying modern high altitude aircraft would require a pressure cabin and in conjunction with this, an individualized pressure garment, to be able to safely penetrate "biological space."

This individualized pressure garment must be comfortable, mobile, take over immediately if cabin pressure is lost, offer protection from effects of rapid or explosive decompression, protection from wind blast, protection from cold, and give complete protection from the hazards of low barometric pressures and extremely low oxygen tension. It should also be as automatic as possible and be able to operate under all conditions. It should also be capable of protection in case of bailout.

The Navy-developed Mk IV fullpressure suit has proven to be the answer to these problems. Before describing the suit and outlining the PR's responsibilities in maintaining it, a brief discussion of pressure is in order.

PRESSURE DEFINITIONS

Pressure is the ratio of force to area. Force may be defined as a push or pull. It is the push or pull exerted against the total area of a surface and is generally expressed in pounds.

Pressure measurement is the determination of the magnitude of force applied to a unit area. For example, atmospheric pressure at sea level is 14.7 pounds per square inch.

Pressure Measurement

Pressure may be measured in several different ways. Table 6-1 compares six of the most common units of pressure measurement with atmospheric pressure. In reading across the table, it can be seen that 1 atmosphere equals:

14.70 pounds per square inch (p.s.i.),
29.92 inches of mercury (in. Hg.),
406.80 inches of water (in. H_2O),
760.00 millimeters of mercury (mm. Hg.)
and 1013.00 millibars (mb.).

Pressure measurements are classified as gage pressure or absolute pressure. Gage pressure is the difference between a given pressure and the atmosphere. Absolute pressure is the total pressure, including that of the atmosphere. Pressures less than atmospheric are called vacuum.

Table 6-1.—Pressure equivalents and conversion factors.

Measurements	atm.	p.s.i.	in. Hg.*	in. H_2O+	mm Hg.	mb.
Atmospheres (atm.)	1	14.70	29.92	406.8	760	1013
Pounds per square inch (p.s.i.)	0.0680	1	2.036	27.68	51.71	68.95
Inches of mercury* (in. Hg.)	0.0334	0.491	1	13.60	25.40	33.86
Inches of water (in H_2O)	0.00246	0.0361	0.0736	1	1.868	2.486
Millimeters of mercury* (mm. Hg.)	0.00132	0.0193	0.0394	0.535	1	1.333
Millibars (mb.)		0.0145	0.0295	0.401	0.750	1

*At 32° F. (0° C); to convert to Hg. at 60° F. multiply by 1.00283.
+At 39.2 °F. (4° C); to convert to H_2O at 60° F. multiply by 1.00096.

To avoid confusion, absolute or gage pressure is often suffixed. For example, 100 pounds per square inch gage pressure (100 p.s.i.g.) or 115 pounds per square inch absolute pressure (115 p.s.i.a.).

For pressures below 20 p.s.i.g., the universally accepted standard of pressure measurement is the manometer, using inches of mercury or inches of water.

Altitude-Pressure Equivalents

Table 6-2 lists various altitudes from 0 to 100,000 feet with corresponding absolute pressures in inches of mercury and pounds per square inch. Pressures every 10,000 feet are underlined for convenience in reading the table. This table will be found useful in testing and calibrating the full pressure suit.

Table 6-2.—Altitude-pressure equivalents.

Altitude (feet)	Absolute pressure (in. Hg.)	Absolute pressure (p.s.i.)
0	29.92	14.70
1,000	28.86	14.20
2,000	27.82	13.68
3,000	26.81	13.18
4,000	25.84	12.70
5,000	24.89	12.22
6,000	23.98	11.78
7,000	23.09	11.35
8,000	22.22	10.92
9,000	21.38	10.50
10,000	20.58	10.10
11,000	19.79	9.72
12,000	19.03	9.35
13,000	18.29	8.97
14,000	17.57	8.63
15,000	16.88	8.27
16,000	16.21	7.97
17,000	15.56	7.65
18,000	14.94	7.34
19,000	14.33	7.05
20,000	13.78	6.76
21,000	13.18	6.47
22,000	12.63	6.22
23,000	12.10	5.95
24,000	11.59	5.69
25,000	11.10	5.45
26,000	10.62	5.22
27,000	10.16	4.97
28,000	9.720	4.77
29,000	9.263	4.57
30,000	8.880	4.37
31,000	8.483	4.17

Table 6-2.—Altitude-pressure equivalents—Continued.

Altitude (feet)	Absolute pressure (in. Hg.)	Absolute pressure (p.s.i.)
32,000	8.101	3.98
33,000	7.732	3.80
34,000	7.377	3.63
35,000	7.036	3.46
36,000	6.708	3.30
37,000	6.395	3.14
38,000	6.096	3.00
39,000	5.812	2.85
40,000	5.541	2.72
41,000	5.283	2.60
42,000	5.036	2.48
43,000	4.802	2.36
44,000	4.578	2.25
45,000	4.364	2.14
46,000	4.160	2.04
47,000	3.966	1.95
48,000	3.781	1.85
49,000	3.604	1.78
50,000	3.436	1.69
51,000	3.276	1.60
52,000	3.123	1.53
53,000	2.978	1.47
54,000	2.839	1.397
55,000	2.707	1.323
56,000	2.581	1.263
57,000	2.460	1.204
58,000	2.346	1.146
59,000	2.237	1.102
60,000	2.132	1.043
61,000	2.033	1.00
62,000	1.938	0.955
63,000	1.847	0.911
64,000	1.761	0.867
65,000	1.680	0.823
66,000	1.615	0.794
67,000	1.530	0.750
68,000	1.470	0.720
69,000	1.400	0.691
70,000	1.330	0.647
71,000	1.265	0.617
72,000	1.210	0.588
73,000	1.150	0.558
74,000	1.090	0.529
75,000	1.040	0.514
76,000	0.990	0.485
77,000	0.960	0.470
78,000	0.920	0.456
79,000	0.880	0.432
80,000	0.875	0.430
85,000	0.645	0.32
90,000	0.509	0.25
95,000	0.402	0.20
100,000	0.315	0.15

MK IV FULL PRESSURE SUIT

The Mk IV full pressure suit is a close fitting, continuous wear garment that provides the pilot protection against the effects of low ambient pressures, explosive decompression, and land and water exposure.

The description, construction, and sizing of the Mk IV full pressure suit, the construction and operation of the Mk II suit controller, and general information on the integration of the suit system with the aircraft are discussed in the following pages. Figure 6-1 is a front view of the complete suit assembly.

The full pressure suit consists of five basic components—the torso, helmet, gloves, boots, and the prescribed undergarment. (See fig. 6-2.) The suit is a flexible pressure-tight garment intended for wear by flight personnel at altitudes above 50,000 feet in order to protect them from the effects of low ambient pressures and of explosive, rapid, or slow decompression. It is also intended to protect the wearer from exposure to extreme ambient and water temperatures, as a result of emergency ditching of an aircraft.

The suit torso is tailored to be a closely fitted coverall-type garment encompassing all of the body with exception of the head and hands. A neck ring is the attachment point of the helmet and also acts as the pivot for

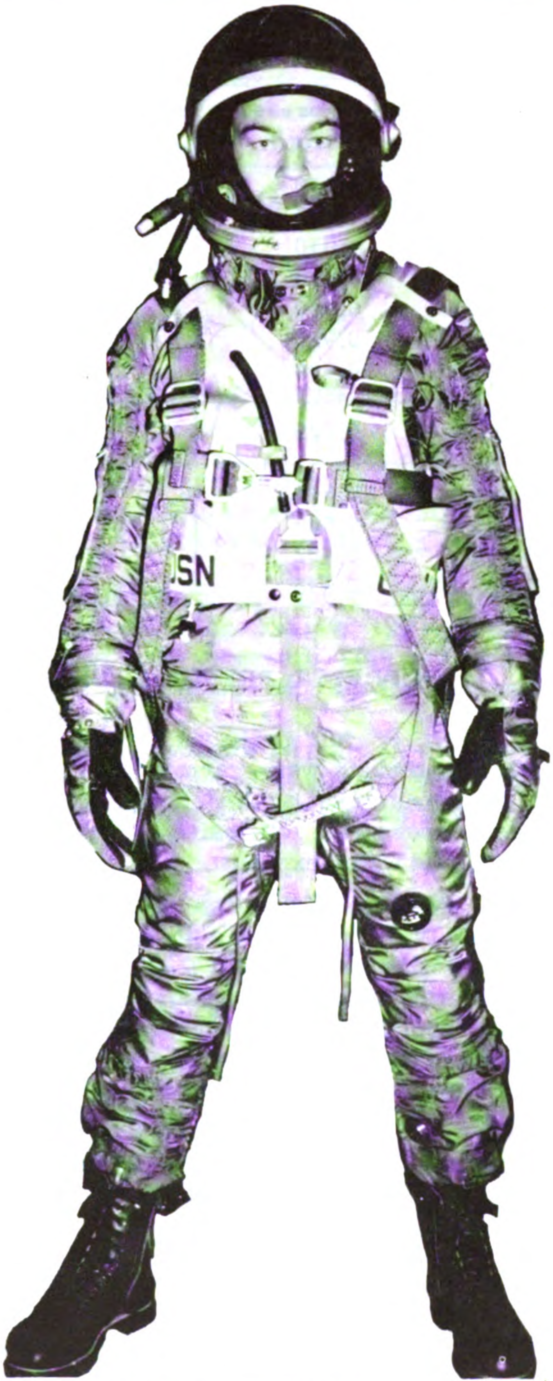


Figure 6-1.—Mk. IV full pressure suit.

the head and neck. Within the helmet is incorporated the breathing regulator and communication system. The gloves extend from the lower one-third of the forearm to the fingertips, and when attached to the sleeve of the torso, form a continuous assembly. The boots extend over the upper one-third of the lower leg to the bottom of the foot and, when worn, form a continuous assembly.

Accessory suit equipment consists of an integrated flotation garment with parachute harness and waffle weave underwear for use in cold climates. An anti-g suit is worn when operational requirements warrant its use. Accessories are shown in figure 6-3.

Under normal conditions, with the cockpit adequately pressurized, the pressure suit remains in an unpressurized state; and any pressurization that occurs is due to high ventilation flows. The ventilation air is supplied from the aircraft's air-conditioning system, monitored through the pilot's manual control valve, and channeled by way of a disconnect into "Trilok ducting" which is an integral part of the torso. This air flows through the ducting and exits at the wrists, ankles, crotch, and periphery of the neck ring. It then flows into the body of the suit so as to remove excess moisture from the body. The air leaves the suit exhaust port and is expelled through the relief port of the suit controller into the cockpit. In addition to ventilating the suit, this air also pressurizes it when required.

The full pressure suit system is designed to respond to and function under several distinct conditions that might be encountered in flight. These conditions are listed below.

1. In normal flight with adequate cabin pressurization, the suit is pressurized only to a very slight extent due to the ventilation airflow.
2. When ambient absolute pressure falls below 3.4 p.s.i. (atmospheric pressure at 35,500 ±1,000 feet), the suit will immediately become pressurized by ventilation air.
3. If the ventilation air is lost above the controller hold, the aircraft oxygen supply will pressurize the suit as well as supply breathing oxygen.
4. In the event of bailout, the emergency oxygen supply will maintain suit pressure as well as supply breathing oxygen.

The design of this oxygen breathing system is unique in that there is never any need for pressure breathing. While wearing the full pressure suit, one never has to resort to pressure breathing above a slight one inch of water pressure.

The freedom afforded by this system of not having a mask tightly cinched across the face

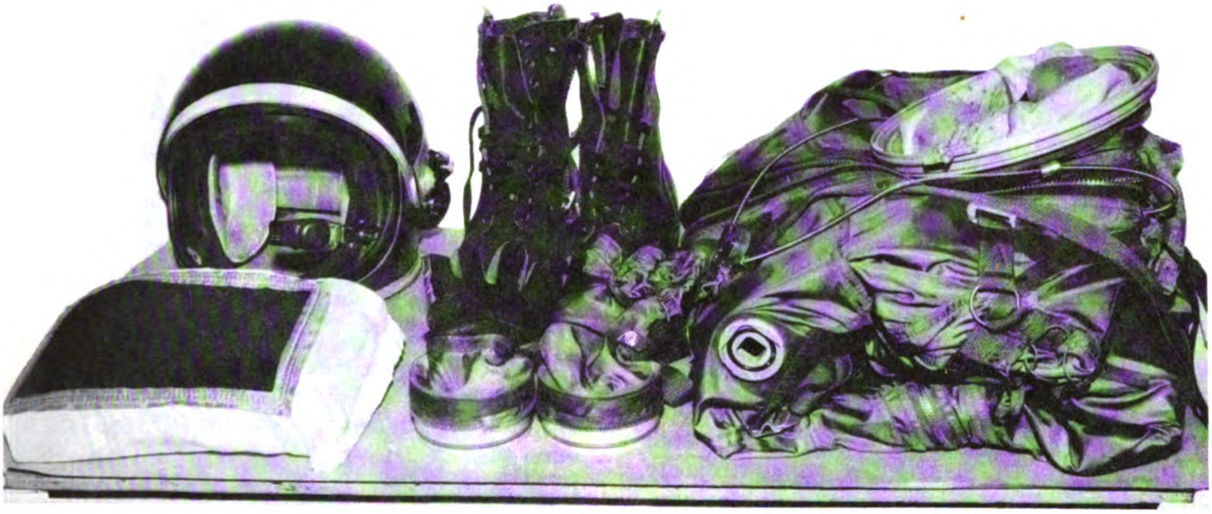


Figure 6-2.—Basic components.

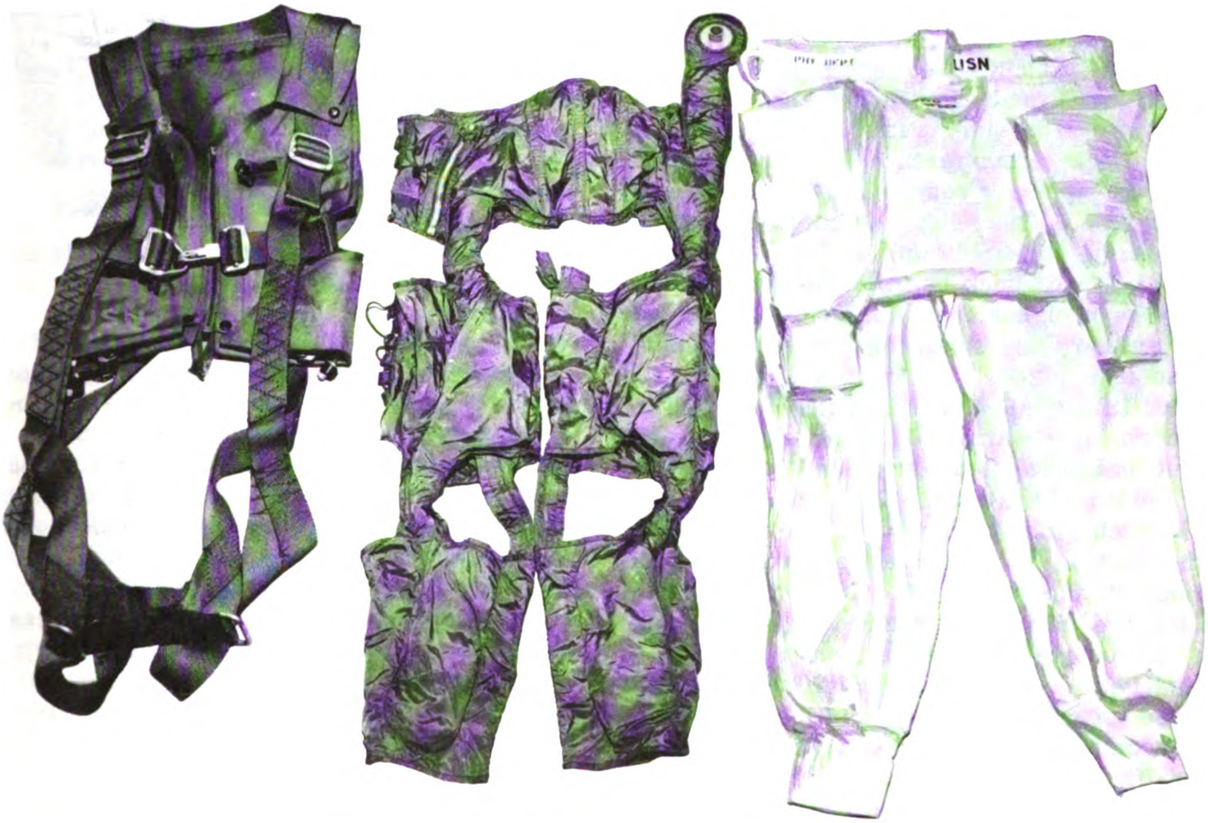


Figure 6-3.—Full pressure suit accessories.

and covering the nose and mouth is also an additional pleasant advantage.

Suit Components

SUIT TORSO.—The suit torso is basically a two-layered garment. It is constructed of an inner airtight layer made of cured neoprene coated fabric and coated Helenca fabric in the stretch areas, with the seams in the inner layer cold cemented. A sage green nylon fabric coverall serves as an outer garment. Entrance to the suit is accomplished by means of a pressure sealing zipper located on a diagonal across the frontal torso section, extending over and terminating approximately 3 inches below and posterior to the shoulder cap. A safety relief valve which relieves at 3.5 to 4 p.s.i. is provided for use in the event of overpressurization of the suit system.

NECK SECTION.—The inner layer of the neck section is made of neoprene coated Helenca knit fabric. The outer restraint fabric has a reduced neck circumference and incorporates two neck zippers, resembling an hourglass configuration. The suit comes in two neck ring bearing assembly sizes; Mk IV, Mod 3, Type 1A—Small neck bearing; Mk IV, Mod 3, 1B—Large neck bearing. Headpieces are sized to fit either the small or large neck ring bearing assemblies.

SHOULDER, ARM, AND LEG SECTION.—The shoulders, upper arm, and wrist sections are without bearings. Provision for shoulder and arm mobility is arranged by means of Helenca knit stretch fabric tailored into the inner layer of the suit in the shoulder, arm, and crotch section of the torso. In addition, the arm and leg are intimately tailored to reduce bulk with the outer ply of these sections having a pleated-type construction to facilitate mobility in these areas. The outer ply of these sections also accommodates a nylon adjustment strap for sizing (fig. 6-4). These straps are channeled along the sides of the arms and legs and are patterned to give a reasonable fit from the 5th to the 95th percentile range of pilot population. Sock-type endings for the legs are made of nylon Helenca fabric, having a thin ply of neoprene gum applied, and are permanently attached to the inner layer of the suit. "Iron Age" boots are provided for wear and restraint.

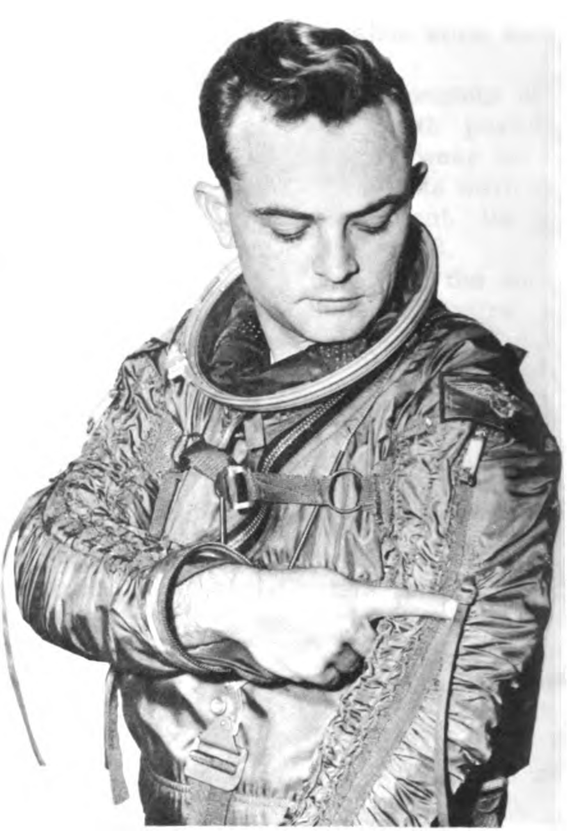


Figure 6-4.—Sizing strap for adjustment.

HELMET AND WAIST SUSPENSION TIE-DOWN.—The helmet holddown system consists of cable, grommet, and pulley arrangements. This system prevents headpiece rise under maximum suit pressure and permits side-to-side nodding at suit pressures up to 1.5 p.s.i. The waist suspension system includes a midsection and two side tiedowns and provides the suit with a "sit-stand" feature. To stand from a sitting position requires a release of the midsection tiedown buckle, thus releasing the webbing restraint and permitting elongation of the torso. To return to the seated position requires tightening of the midsection webbing.

SUIT SERVICE CONNECTIONS.—There are 3 suit port fittings located in the upper torso below the left and right armpits—the anti-g suit fitting, located in the left front; ventilation garment fitting in the left rear and the suit exhaust in the right front. Associated hose nozzles with positive lock-type fittings mate with the port fittings.

The latest model of the Mk IV full pressure
iit is equipped with a direct reading altimeter
cated on the frontal thigh of the left leg.
these suits, the indicator port comes equipped
ith a removable plug. This port, although
t required during flight, is needed for use
iring sea level testing in conjunction with the
essurization control test kit.

INTEGRAL VENT SYSTEM.—The integral
nt system, which distributes the flow of
ntilation air, consists of a manifold plenum
amber with six outlets. Tubes of fabric
d Trilok distribute the air efficiently to the
ists, ankles, crotch, and neck areas. A
iitable check valve, which maintains the
tegrity of the suit in the event of vent hose
paration, is incorporated within the inlet
rt fitting. Figure 6-5 is an internal view of
e torso, showing inner layer construction
d the suit vent system.

SUIT SIZES AND SIZING.—The basic suit
mponents are fitted to a particular individual
a selection of properly sized components
d, in the case of the suit torso, by means
adjustable features of the suit.

The suit torsos are supplied in 12 stock
zes, 6 basic chest sizes, patterned with
ther a short or long vertical trunk size.
ee table 6-3.) These stock sizes are based
a relationship between the individual's
panded chest circumference and vertical trunk
rcumference only. Suit fitting of an individual
accomplished by selection of a stock size
iit most comparable to the individual's
panded chest and vertical trunk dimensions.
Functional" fitting is attained by the use of
e length adjustment straps and circumferential
cing adjustments, as required. For maximum
erational suitability, a functional fit is a
cessity.

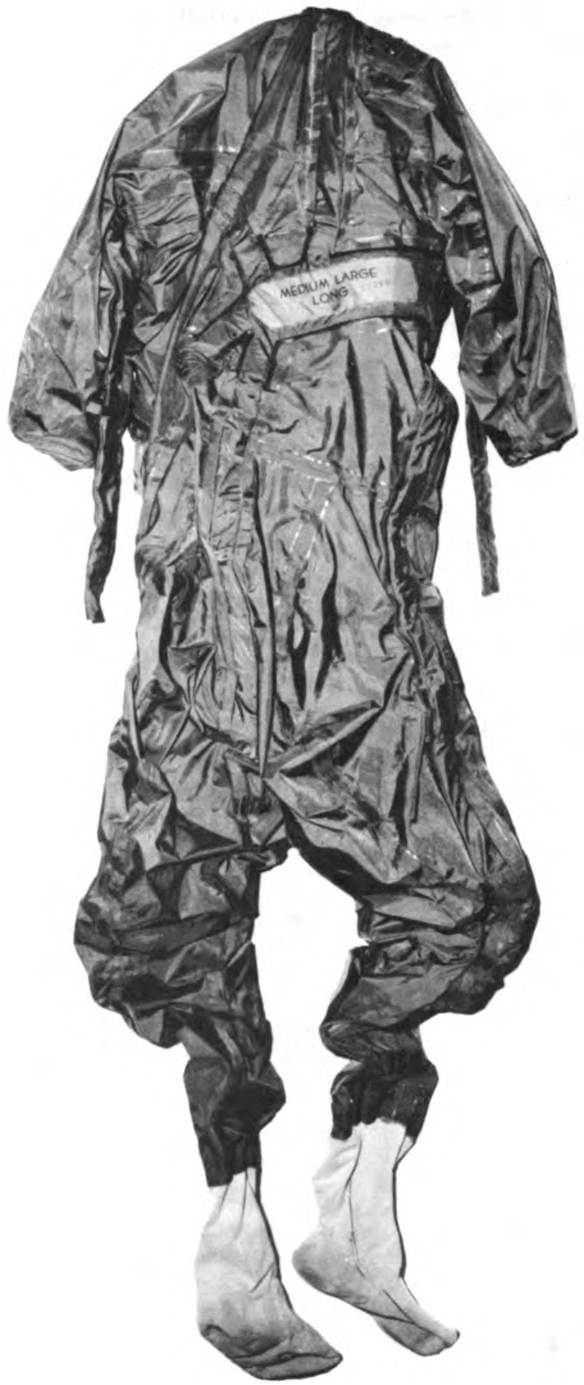


Figure 6-5.—Internal view of torso, showing inner layer construction and suit vent system.

HELMET.—The helmet (fig. 6-6) is con-
ructed from phenolic resins and fiberglas
oth and is designed to provide for maximum
sibility, comfort, mobility, wind blast pro-
ction, crash protection, ease of donning,
moval, and simplicity of operation. It is
ovided with a head suspension system, an
C-10 communication system, and a face seal
at prevents leakage in either direction; i.e.,
r or oxygen. An exhaust check valve permits
e exhaled gas to pass from the respiratory
ction into the torso section. The oxygen
gulator is a demand type that delivers at a positive pressure 100 percent oxygen, and can be turned ON and OFF manually. The ON-OFF button on the model GR-90 regulator automatically deflates the visor seal when in

Table 6-3.—Schedule of stock suit sizes.

MK-IV pressure suit sizes	Expanded chest dimension (in inches)	Crotch height
Small short (SS)	to 37.25	To 33
Small long (SL)	to 37.25	To 36
Small medium short (SMS)	37.25 to 38.87	To 33
Small medium long (SML)	37.25 to 38.87	To 36
Medium short (MS)	38.87 to 40.75	To 33
Medium long (ML)	38.87 to 40.75	To 36
Medium large short (MLS)	40.75 to 42.00	To 33
Medium large long (MLL)	40.75 to 42.00	To 36
Large short (LS)	42.00 to 43.50	To 33
Large long (LL)	42.00 to 43.50	To 36
Extra large short (XLS)	43.50 up	To 33
Extra large long (XLL)	43.50 up	To 36

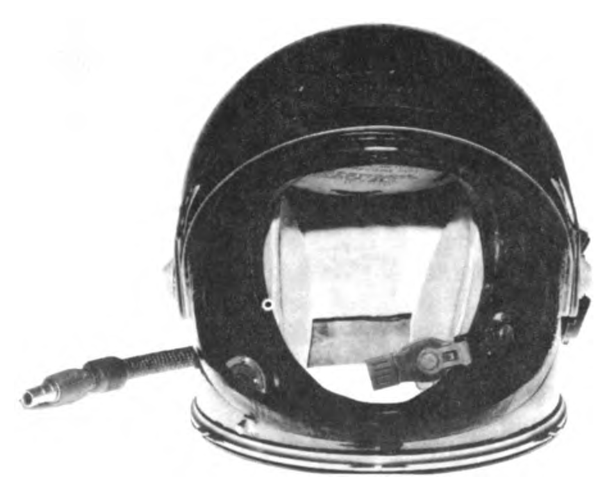


Figure 6-6.—Helmet.

OFF position, enabling the wearer to open the visor after inhaling to bleed off pressure.

VISOR.—The lens configuration is made of Plexiglas and permits the wearer to see to the full extent without optical distortion. It is retractable; and when in a closed position with oxygen ON, maintains its integrity by means of a pneumatic seal that locks the visor in a leaktight closed position. A retractable tinted plastic lens, which affords approximately 17 percent light transmission, is also provided for sunglare protection, and trunnion knobs are provided on either side of the visor for actuation of the clear or tinted visor.

FACE SEAL AND ADJUSTMENTS.—The face seal separates the respiratory section from the suit section. The wide soft rubber seal is cemented to a soft aluminum frame which can be bent to conform to the symmetry of the face. A knob on the right exterior of the headpiece is used to effect a tight face seal by means of an internal worm gear assembly.

COMMUNICATIONS.—The earphones mounted inside the headpiece are the full comfort type and can be adjusted up or down. A boom-type (AIC-10) microphone is mounted on the aluminum face seal frame. The lead wires for the communication system are molded into the oxygen delivery hose on the helmet.

OXYGEN REGULATOR.—A Firewel GR-90 positive pressure, demand oxygen regulator is attached to the headpiece and delivers breathing oxygen to the respiratory section under a positive pressure of 1.0 to 1.5 inches of water. This positive pressure is provided to prevent any ventilation air leaking from the suit through the face seal and thereby diluting the breathing oxygen in the respiratory section.

The oxygen flows into the headpiece to the area between the face seal and the visor. It enters this area through a perforated tube surrounding the visor area and flows across the visor so that it serves the dual purpose of supplying breathing oxygen and also a supplemental means of defogging the visor.

EXHALATION VALVE.—Exhaled air passes out of the headpiece through an exhaust valve into the body of the suit. The exhalation valve is made of aluminum and cemented into the diaphragm near the chin level. The valve is spring loaded to two inches of water pressure and has a mica disc seat. The pressure-compensated exhalation valve is designed to maintain the positive pressure supplied to the respiratory section.

NECK BEARING.—To enable the pilot freedom of head movement in both the ventilated and pressurized state, a neck bearing is provided in the neck section. This bearing consists of alternating nylon and steel balls that rotate in n inner and outer race. A Teflon seal sup-lemented by a rubber quadrant O-ring seal ive the bearing its airtight and watertight haracteristics.

GLOVES.—The gloves provided for the pres-ure suit are constructed of the same material s the body of the suit and have leather-overed palms for greater wear. A palm estraining wire is bent to fit the hands in rder to prevent the palm of the gloves from allooning when pressurized. Gloves are pat-rned in 13 sizes and furnished in 5 palm izes of small, medium, large, and extra arge, with each palm size available in short, egular, and long finger sizes. The gloves are ttached by means of a male and female isconnect that contains an O-ring seal to revent leakage. The gloves are secured by slide fastener zipper.

BOOTS.—The leather "Iron Age" boots are orn over the air retaining boot sections and re modified to incorporate a zipper for sim-licity and ease of donning and doffing.

SUIT CONTROLLER

If any one item of equipment in the full ressure suit system could be considered the eart of the system, the suit controller (fig. -7) is that item.

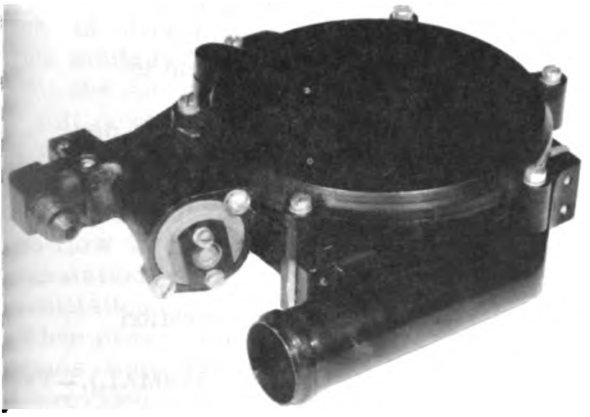


Figure 6-7.—Suit controller.

The suit controller controls the pressure the suit by regulating the rate of exhaust ventilation air and by controlling the flow oxygen into the suit.

The suit controller will maintain the suit at preset pressure of 6.9 inches of mercury ±0.3 inch or 35,500 feet ±1,000 feet. This preset pressure is referred to as the controller hold.

This controller is designed to operate and function under temperature conditions ranging from -65° F. to +160° F. It is designed as a high flow, low resistance type controller. This design resulted from a requirement for more flow and less resistance to more satisfactorily meet the high temperature conditions being encountered by fleet pilots. The Firewel controller is capable of delivering up to 700 l.p.m. flows, however, the ventilation air control valve can only pass up to a 300 l.p.m. flow.

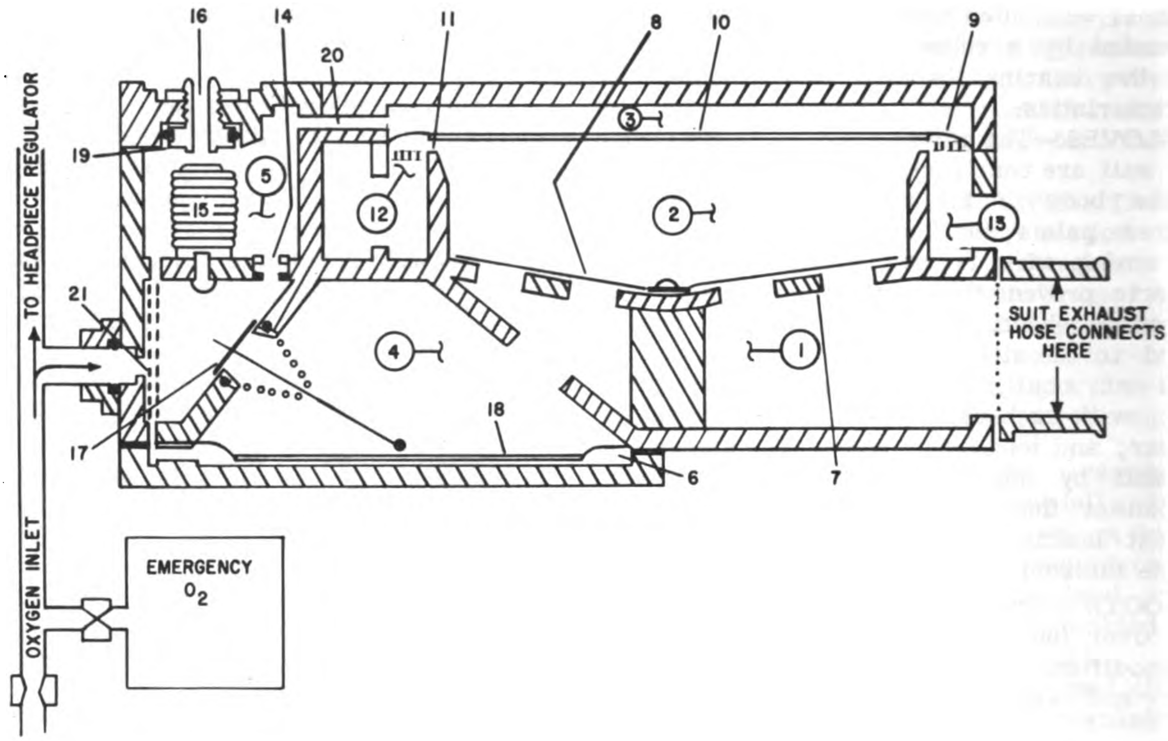
In normal flight, with cabin pressure, ventilation air passes through the suit to the controller and then escapes into the cabin. If cabin pressure fails above 35,500 feet, but pressure is still available from the engine, the controller keeps the suit pressure to the correct absolute pressure of 35,500 feet. But, if pressure from the engine is also lost, aircraft oxygen, in addition to being used for breathing, will be automatically supplied by the controller to maintain the correct suit pressure. If the aircraft oxygen system fails, then the emergency system must be cut in, either manually or automatically, to accomplish the same purpose.

The suit controller has six basic compartments, each serving a very useful purpose. They are: suit, aneroid, demand valve control, suit demand, and water check valve compartments.

Operation

Aircraft oxygen, operating on a pressure of 80 ± 10 p.s.i., passes through the composite disconnect to the bailout reducer and to the controller. From the controller it is also routed to the headpiece regulator.

Where the oxygen enters the controller (fig. 6-8) is a metering orifice consisting of a sintered bronze filter and a crimped orifice (14), preset to allow a bleed flow of 100 to 150 ccm of oxygen into the aneroid compartment (5). From the aneroid compartment are two ducts (20) and (21), through which the bleed flow passes. There is also an adjustable aneroid vent orifice (16), which normally vents the bleed flow to the cabin or atmosphere. The two ducts (20) and (21) direct the bleed flow into the suit control compartment (3) and also into the demand valve control compartment (6).



1. Suit compartment.
2. Water check valve compartment.
3. Suit control compartment.
4. Suit demand compartment.
5. Aneroid compartment.
6. Demand valve control compartment.
7. Seat, water check valve.
8. Diaphragm, water check valve.
9. Diaphragm, exhaust control.
10. Exhaust control diaphragm facing.
11. Seat, diaphragm exhaust control.
12. Exhaust port.
13. Exhaust port.
14. Orifice assembly, control pressure.
15. Aneroid.
16. Aneroid compartment vent orifice.
17. Demand valve assembly.
18. Demand valve diaphragm.
19. Valve, adjustable.
20. Duct, aneroid compartment to suit control compartment.
21. Duct, aneroid compartment to demand valve control compartment.

Figure 6-8.—Schematic diagram of suit controller.

Suit ventilation air, leaving the suit and entering the controller through the controller exhaust inlet will normally enter the suit compartment (1) and the suit demand compartment (4). This ventilation air pressure will lift the water check valve (8) and force the exhaust control diaphragm (9) off its seat (11) and exhaust from the controller through the controller exhaust ports (12) and (13). These ventilation exhaust ports are built in around the periphery of the controller case, thus allowing a high ventilation exhaust with very little resistance.

Conditions of Operation

VENTILATION ONLY (NORMAL).—Ventilation air, which is supplied by the compresso section of the aircraft engine, passes throug a disconnect, through the ventilation system the suit, and is exhausted through a hose to th controller. The exhaust air forces the exhaus diaphragm (10) open and allows the ventilatio air to pass through the exhaust ports (12) an (13) to the cabin or atmosphere. This ventilatio pressure is also sensed in the suit deman compartment (4) and prevents the demand valv ontrol diaphragm (18) from actuating the demand valve (17). Therefore, we simply have a flow of ventilation air passing through the suit to the controller and being vented to the cabin, mainaining bodily comfort for the pilot. This flow of ventilation air is controlled by the pilot.

VENTILATION PRESSURIZATION.—As long s the cabin pressurization system is intact nd functioning, the ventilation air passes hrough the suit and the controller to the cabin s described above. The only suit pressure n this case is caused by the restriction of he flow of ventilation air through the suit and he controller (approximately 0.03 inches of mercury for a 300 l.p.m. flow). If cabin ressure is lost below controller hold altitude 35,500 feet), these same conditions will exist. f, however, the cabin pressure is lost above ontroller hold altitude, the suit controller will monitor the flow of exhaust air from the conroller at a rate sufficient to maintain a pressure n the suit equivalent to 35,500 feet ambient. his is accomplished by the expansion of the neroid (15) restricting the bleed flow through he aneroid vent orifice (16), causing a slight ressure buildup in compartments (3) and (6) which the exhaust air from the suit must overome to unseat the exhaust control diaphragm 10).

AIRCRAFT OXYGEN PRESSURIZATION.—If he jet engine failed, the cabin pressurization, which is dependent on the operation of the ngine would be lost, and the source of ventilation ir for the suit also would be lost. In this event, he suit controller, at altitudes above 35,500 eet would automatically (by aneroid expansion) rap the required differential pressure in the uit. Under this emergency condition, there s no flow through the suit except the exhaust f exhalation gases, and consequently, there is o ventilation of the suit.

When pressurized in this manner, the system ecomes static except for the exhalation gases nd provided there is no suit leakage. If the uit has leakage and if the exhalation gases re not sufficient to make up this leakage, this rop in pressure is sensed in the suit compartment (1) and the suit demand compartment (4). n this case the aneroid has blocked off the neroid vent orifice, causing a pressure buildup n the suit control compartment (3), the aneroid ompartment (5), and the demand valve control ompartment (6). When sufficient pressure has built up to overcome the pressure in compartments (1) and (4), the demand valve control diaphragm starts an inward movement towards the demand valve (17). At this same time, the pressure buildup in the suit control compartment (3) has closed off the suit exhaust control diaphragm (9), preventing the exhausting of suit pressure through the controller exhaust ports (12) and (13).

The demand valve control diaphragm (18) will push against the tip of the demand valve, (17), causing a flow of oxygen to enter the controller to the suit demand compartment (4), the suit compartment (1), and into the suit.

When suit pressure has equalized with control pressure, the demand valve control diaphragm (18) will be forced back to its neutral position, allowing the demand valve (17) to close, shutting off the flow of oxygen into the controller until such time as suit pressure should once more drop below controller pressure.

It is easy to realize that if oxygen were allowed to circulate through the suit for purposes of ventilation, the aircraft supply or the emergency supply would be depleted in a very short time.

BAILOUT OXYGEN PRESSURIZATION.—In case of an emergency and the pilot must bail out, the bailout system located in the seat kit assembly will provide breathing oxygen and act on the suit in exactly the same manner as that described above for "Aircraft oxygen pressurization." The bailout system operates the same as the aircraft oxygen pressurization; thus, there is no actual flow of oxygen through the suit for ventilation purposes. The bailout unit will supply breathing oxygen and will also supply oxygen to maintain the required differential suit pressure that might otherwise be lost by suit leakage.

The oxygen is delivered from the bailout cylinder in a manner described in the following section.

BAILOUT UNIT

The bailout unit is mounted in the seatpan of the ejection seat. A schematic diagram of the bailout unit and its components is shown in figure 6-9. The bailout unit serves a dual purpose—it provides an emergency supply of breathing oxygen and an emergency source of pressurization. All the services to the pilot are provided automatically.

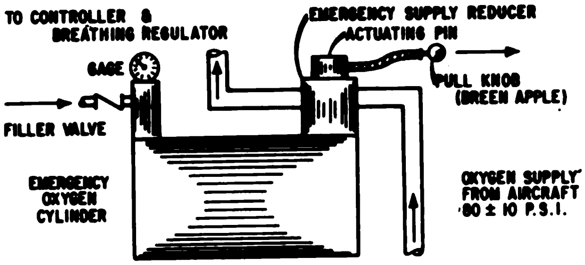


Figure 6-9.—Schematic diagram of bailout unit.

Operation

When the locking pin is pulled from the top of the pressure reducer, a spring in the upper part of the reducer is allowed to descend against a diaphragm. The spring exerting pressure on top of the diaphragm is preset to balance a pressure of 50 ± 10 p.s.i. (gage). When the pressure on the opposite face of the diaphragm decreases, the spring moves the diaphragm against the stem of a valve located in the lower portion of the reducer. The actuation of this valve supplies oxygen from the bailout cylinder until the diaphragm is moved up against the force of the spring. Thus, oxygen from the cylinder at pressures from 250 to 2,000 p.s.i. is supplied at a reduced pressure of 50 ± 10 p.s.i.

Automatic Bailout System

The normal route of the oxygen aircraft supply is through the emergency system reducer so that the oxygen passes under the previously described diaphragm. The aircraft oxygen is supplied at a nominal pressure of 70 p.s.i.

The duration of the bailout unit at sea level is 10 to 12 minutes. Duration at suit-controller-hold altitude and above is approximately 20 minutes.

BREATHING REGULATOR
(GR-90 AND GR-70)

The Firewel GR-90 regulator shown in figure 6-10 delivers 100 percent oxygen under a slight positive pressure of 1.5 inches of water. It operates on 40 to 90 p.s.i. inlet pressure. The GR-90 oxygen breathing regulator performs the following functions:

1. Supplies breathing oxygen to the respiratory section.

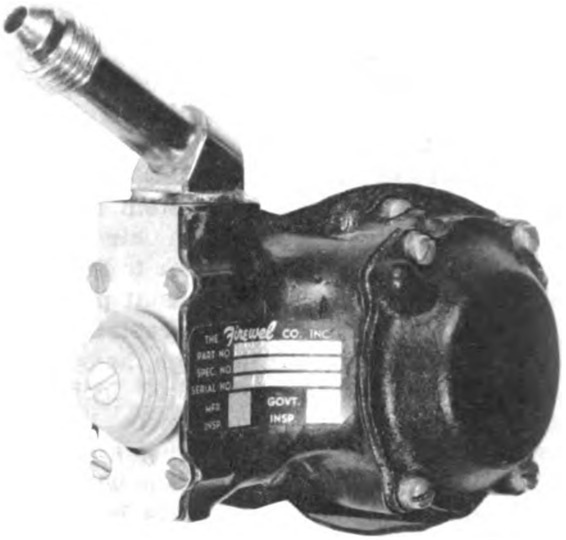


Figure 6-10.—Firewel GR-90 oxygen breathing regulator.

2. Defogs the visor.
3. Supplies pressure to the visor pressur seal.

Construction

A schematic diagram of the Firewel GR-9 regulator is shown in figure 6-11. The ca of the regulator is made of cast aluminu and is divided into two main compartments reference suit pressure compartment an respiratory pressure compartment.

These two compartments are separated by silicone diaphragm. The diaphragm is sprin loaded in the reference suit pressure compartment to deliver a positive pressure of 0.5 t 1.5 inches of water. A tilt valve stem extend into the respiratory pressure compartment.

The GR-90 regulator has two pressure sensing lines. One line, commonly referred to as the compensating line, senses suit pressur to the reference suit pressure compartment The other line senses pressure from the respiratory section of the headpiece to the respirator pressure compartment of the regulator.

A two-position ON and OFF button control the supply of oxygen to the regulator and control inflation and deflation of the visor seal. Th visor seal is inflated when the control butto is in the ON position. The seal pressure i

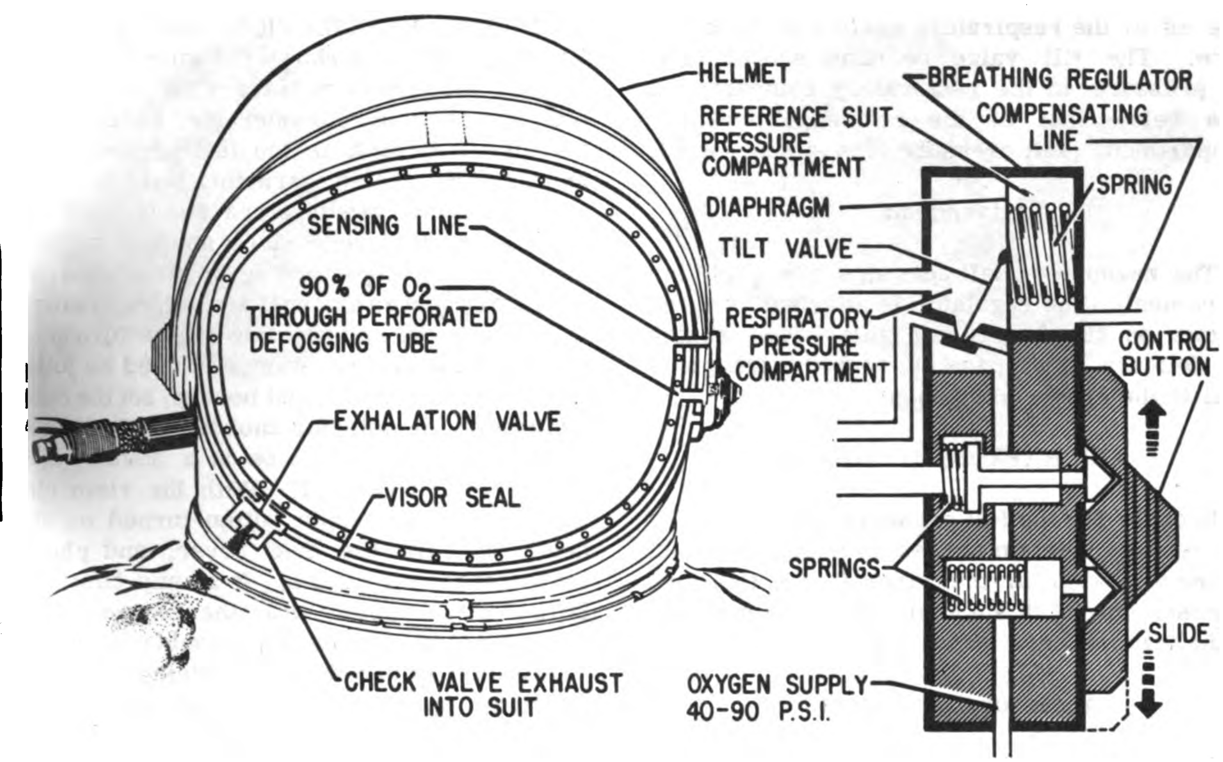

HELMET
BREATHING REGULATOR
REFERENCE SUIT PRESSURE COMPARTMENT
COMPENSATING LINE
SPRING
DIAPHRAGM
TILT VALVE
SENSING LINE
90% OF O_2 THROUGH PERFORATED DEFOGGING TUBE
RESPIRATORY PRESSURE COMPARTMENT
CONTROL BUTTON
EXHALATION VALVE
VISOR SEAL
SPRINGS
SLIDE
CHECK VALVE EXHAUST INTO SUIT
OXYGEN SUPPLY 40-90 P.S.I.

Figure 6-11.—Schematic diagram of Firewel GR-90.

ntrolled by a spring-loaded valve. The essure for the visor seal is tapped off the ygen delivery upstream of the tilt valve. his is referred to as the lower chamber. eflation of the visor seal is automatically complished by placing the ON-OFF button in e OFF position. The visor may then be opened.

Operation

The oxygen supply flows from the inlet to e upper valve chamber. When the oxygen pply control button is in the ON position, e oxygen flow is directed to the tilt valve d also inflates the visor seal.

The suit pressure is sensed in the reference essure compartment. This pressure, in addion to the 1.5-inch water pressure applied by e spring, is exerted on the diaphragm. This ombined pressure distends the diaphragm, epressing the tilt valve stem, which, in turn, seats the tilt valve. This operation allows pproximately 90 percent of the oxygen to flow om the tilt valve through the defogging tube d into the respiratory section of the headiece. The remaining 10 percent flows through the tilt valve and through the respiratory pressure compartment and thus to the respiratory section of the headpiece.

The defogging tube follows the perimeter of the visor. As mentioned before, the defogging tube has perforations which cause the incoming oxygen to wash across the visor, accomplishing the defogging.

The oxygen flow will pressurize the respiratory section of the headpiece until it is equal to the reference pressure side of the diaphragm. This pressure applied to the bottom of the diaphragm returns it to its neutral position, allowing the tilt valve to close; thus the flow of breathing oxygen ceases.

If the pressure of the respiratory section of the headpiece was transmitted to the respiratory pressure compartment through the defogging tube, the tilt valve would be kept open too long, putting too much pressure in the respiratory section of the headpiece. To overcome this difficulty, approximately 10 percent of the flow of oxygen is diverted along the tilt valve stem into the respiratory pressure compartment. In this manner, the pressure is built up in the respiratory pressure compartment at the same time as in the respiratory section of the headpiece. The tilt valve remains seated until the pressure in the respiratory compartment falls below that of the reference pressure compartment (suit pressure plus spring force).

Attachment

The headpiece shell acts as a base plate for attachment. The regulator is attached by three screws on the lower left side. The sensing and delivery tubes pass through the headpiece shell to the proper component.

AIRCRAFT COMPONENTS

In order for the full pressure suit to be used successfully, certain accessory equipment must be incorporated in the aircraft. A thorough understanding of this equipment is as important as the full pressure suit itself.

Accessory Equipment

The following accessory items are incorporated into one panel: pressure reducer, ventilation air control valve, inlet fitting for external ventilation air, oxygen gages, and control knob for temperature selection.

PRESSURE REDUCER.—The oxygen pressure reducer is cam-lever operated and works on the same principle as the bailout pressure reducer. The pressure reducer is preset to deliver 80 ± 10 p.s.i. This reducer is not used when the aircraft is equipped with a liquid oxygen system. An OFF-ON valve is used in this case. In either case, there is a safety valve that will pop off at 120 ± 10 p.s.i.

INLET FITTING FOR EXTERNAL VENTILATION AIR.—This inlet fitting is similar to the female fitting on an oxygen feeder hose. A dust cover is utilized to prevent foreign matter from entering the valve. The inlet fitting is a component of the ventilation flow control valve, described below.

GAGES.—A standard 1,800 p.s.i. high-pressure gage and shutoff valve are used when the aircraft has a gaseous oxygen system. A liquid oxygen quantity gage is used for a liquid system.

VENTILATION FLOW CONTROL VALVE.—The ventilation flow control valve is shown in figure 6-12. The valve has 3 selections: OFF, AIRCRAFT VENTILATION, and EXTERNAL VENTILATION, as shown in figure 6-13.

It is sometimes necessary for the wearer to don the suit a considerable time prior to takeoff. Inasmuch as the full pressure suit is an airtight, sealed garment, body heat would soon raise the temperature and humidity to an uncomfortable level. Since normal suit ventilation air is dependent upon the engine, it is necessary that an external air source be provided to ventilate the suit prior to engine turnup.

The external air source is used as follows: After preflight check and hookup, set the console ventilation air selector knob to EXTERNAL AIR. Since the aircraft will be in a standby status, the oxygen will be ON. With the visor closed and the oxygen supply button turned on at the headpiece, lift the dust cover, and plug into the external air fitting. If at any time ventilation is attempted with the oxygen off, the headpiece or the gloves should be removed. Ventilation should never be attempted with only the visor open. The flow is preset; therefore, the pilot will have no control over regulating the flow.

Just prior to engine start, remove the hose from the external air fitting. Depress and rotate the ventilation flow control knob clockwise until it pops up after engine start. Regulate the flow to the ventilation garment by rotating the knob clockwise to increase the flow.

Readyroom ventilation is also provided for, because it is assumed that flight personnel will be dressed prior to briefing. This period may last from a half hour to several hours.

To meet this problem, an air outlet is provided at each seat in the readyroom. Using an auxiliary power source, ventilation air can be supplied to each pilot. By this system each person keeps comfortable by ventilation air. The ventilation air may be delivered at a predetermined temperature and flow, or individually selected by the seat occupant.

ASSISTING PROCEDURES

In the course of his work in the full pressure suit field, a Parachute Rigger will be required to assist flight personnel with their suit systems. In order to render this assistance, the Parachute Rigger must be thoroughly familiar with the proper donning and doffing procedures, cockpit hookup and testing, care, and maintenance of the suit systems.

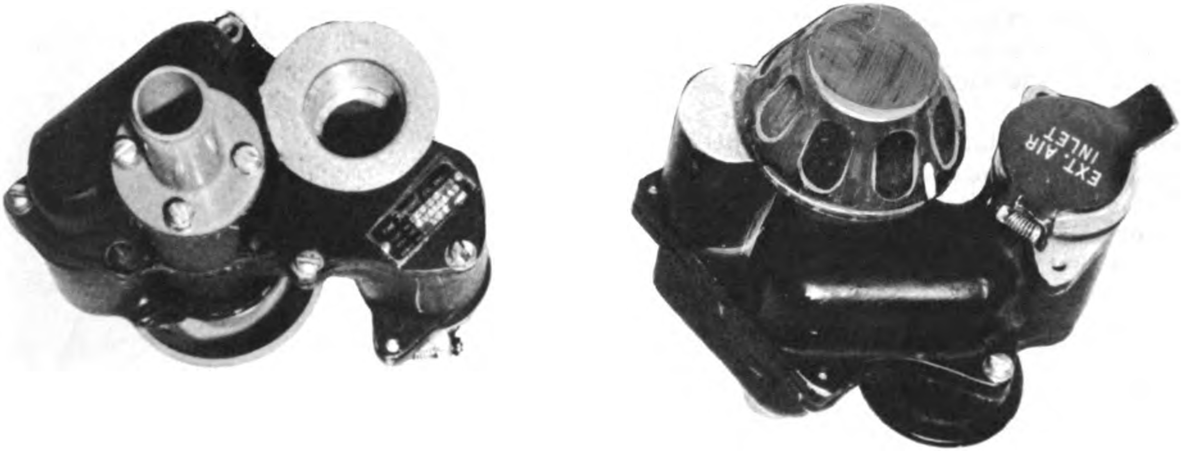


Figure 6-12.—Ventilation flow control valve (Firewel F-2020).

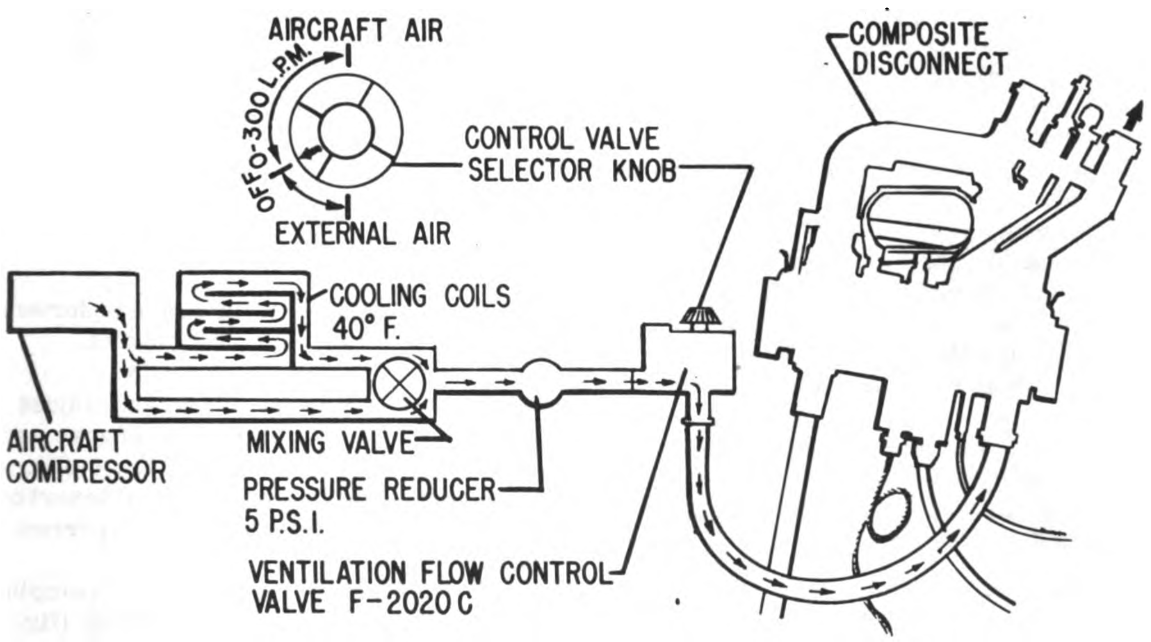


Figure 6-13.—Schematic of aircraft ventilation system.

Readyroom Assisting Procedures

The pilot should require only a minimum of ssistance in donning the suit system, but in rder to facilitate the donning, the following hould be observed.

Before donning of the suit, make a visual spection to determine the completeness of the tire suit assembly.

All tiedown straps should be free of buckles.

Neck sections and foot section zippers should be open.

Snap fasteners in neck section should be open.

Entrance zipper should be open (waist gusset zipper closed at this time).

Visually inspect that O-rings are present in suit port fittings; i.e., vent air, anti-g, suit exhaust, etc. If no anti-g suit is to be used, make sure that the port is plugged.

Inspect and wipe clean the pressure sealing lips on the entrance zipper and apply a light film of silicone lubricating grease, Spec. MIL-L-4343A.

Check to see that the O-ring is present in the helmet and is seated properly.

Clean the headpiece visor inside and out and apply antifogging solution if needed.

Check helmet for operational suitability and completeness of assembly.

Engage oxygen hose and communication plug.

Lower retractable clear visor.

Turn oxygen on at console and actuate slide valve on regulator to ON position.

Check visor for effective seal.

Turn oxygen off at console and check visor for effective seal.

Deflate visor seal, open visor, and check communications system.

Check flotation garment for completeness of assembly, making certain that live CO_2 cartridges are present and canister secured (flotation garment should be evacuated of trapped air before donning).

With the predonning inspection completed, the suit is now ready for donning.

The following procedure is suggested for maximum wearer comfort, minimum donning time, and proper operation of the suit.

Donning Procedure—Mk IV Full Pressure Suit

The step-by-step procedure for donning the full pressure suit is as follows:

1. Don waffle weave underwear (fig. 6-14) (for cold weather operations).

2. Don prescribed cotton undergarment and woolen socks (fig. 6-15). Pull socks up smoothly over legs of undergarment. (Prescribed cotton undergarment has a Trilok patch on the right side, adjoining the suit exhaust port, and two in the upper thigh areas of the torso legs.)

3. Don anti-g suit (optional). (See fig. 6-16.) Attach at waist first, then zip up legs, smoothing out undergarments.

4. Don lightweight full pressure suit as follows:

Assume a seated position and insert one leg into corresponding leg of the body section (fig. 6-17). Insert the other leg, then stand and pull suit over hips (fig. 6-18).

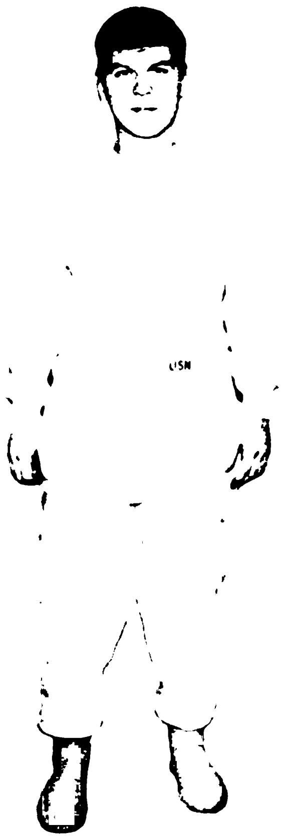


Figure 6-14.—Waffle weave underwear for use in cold climates.

Assume sitting position and adjust stockinettes to fit feet comfortably, engage and clos ankle zippers, and don boots (fig. 6-19).

Assume standing position and insert one arm (fig. 6-20), then the other through correspondin arm section.

Open the waist gusset zipper completely t assure elongation of torso section (fig. 6-21)

Support neck bearing section over and abov head and "roll" head through neck bearin assembly (fig. 6-22).

Visually inspect the relief zipper in th inner liner—IT MUST BE SECURED.

Close the waist gusset zipper, making sur the inner liner is free of the zipper slider whe closing.

Close the neck zipper and snap fasteners i the neck section.

Close the entrance zipper (fig. 6-23), takin care to pull in line with the zipper chain

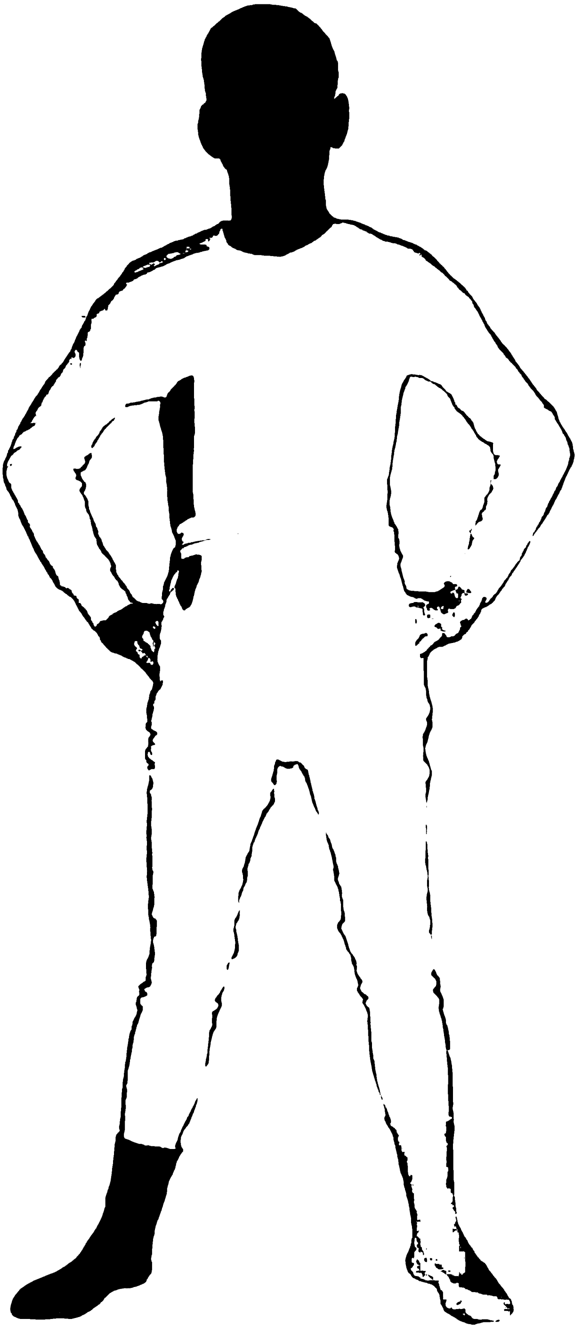


Figure 6-15.—Cotton undergarment showing Trilok screen.

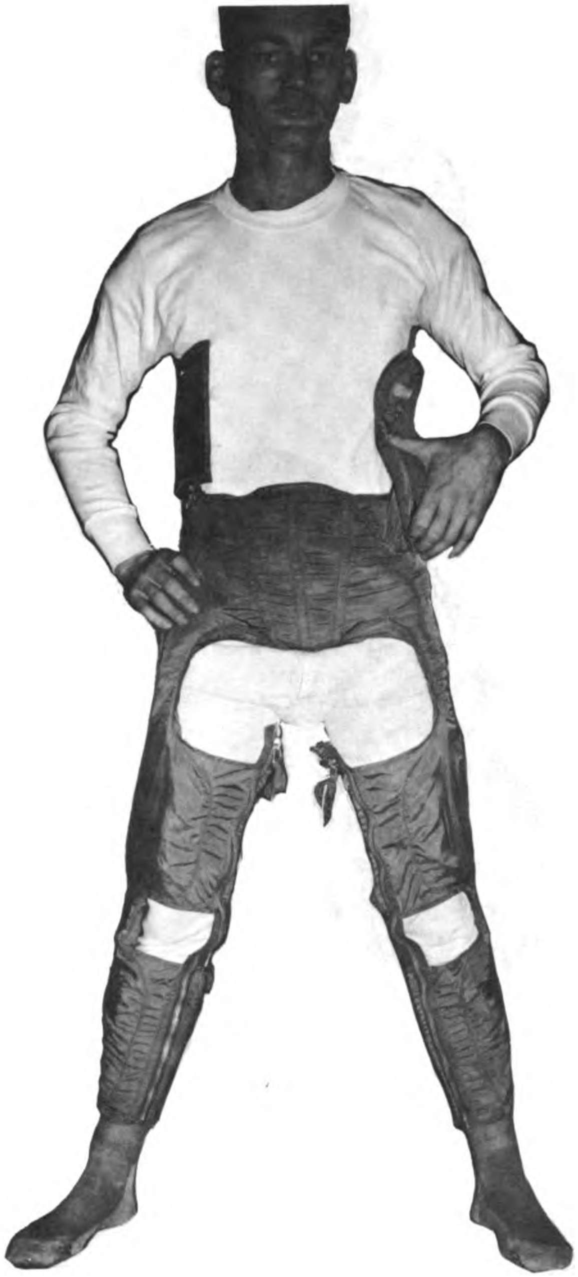


Figure 6-16.—Anti-g suit (Z-3 cutaway modified).

d making sure the slider is pulled securely to the closure ending.

NOTE: At this point the Parachute Rigger onnects the suit to the ventilation air supply r wearer comfort. The procedure is as llows:

Insert chest strap through buckle and adjust to predetermined marking.

Insert upper front tiedown strap through buckle (this strap should not be adjusted to marking until after helmet is engaged).

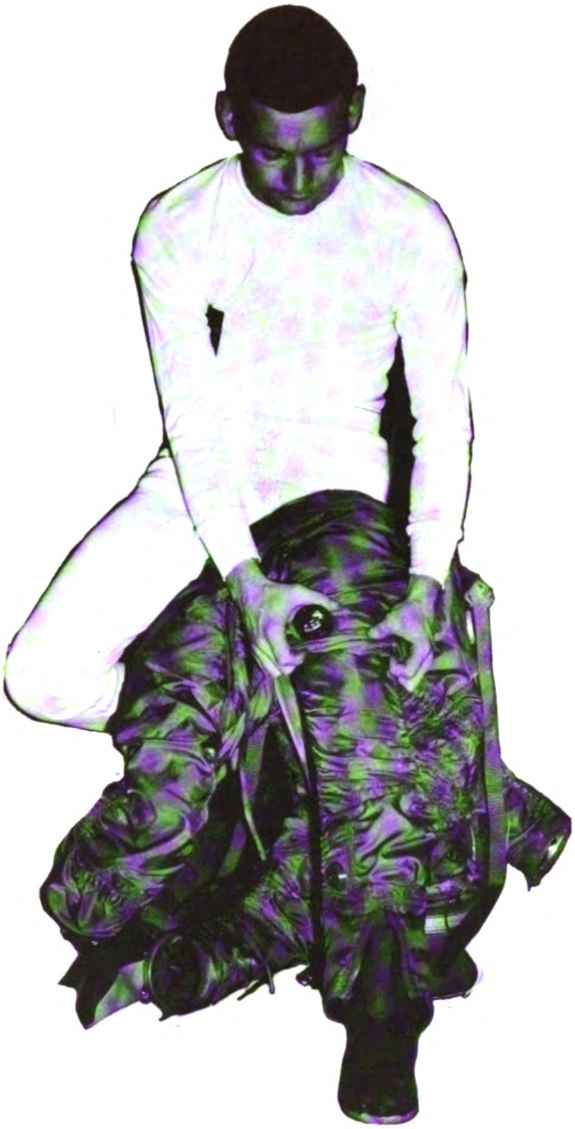


Figure 6-17.—Inserting leg into leg section.

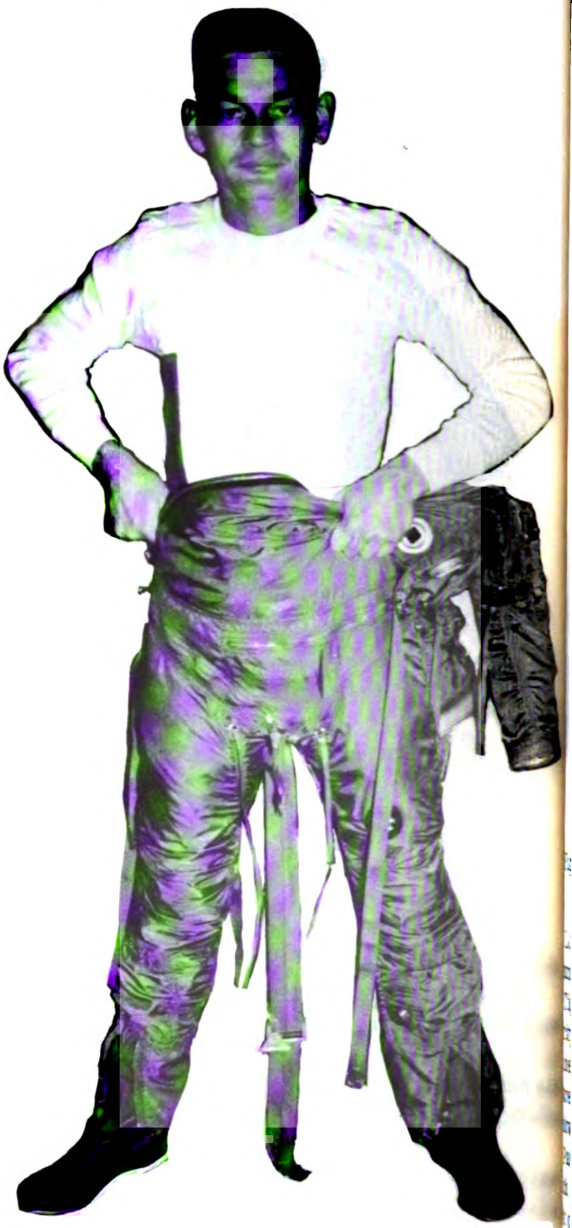


Figure 6-18.—Adjusting suit over hips.

Insert lower front tiedown straps through buckle.

Insert left and right side tiedown straps through buckle.

Lower front and side tiedown straps should be tightened just enough so that the wearer does not have to stoop while standing.

The lower front and side tiedown straps provide final adjustment when seated in the cockpit.

CAUTION: Tiedowns must be adjusted to predetermined markings when seated to prevent headpiece and upper portion of body sectio from lifting when the suit is pressurized.

Before donning helmet, loosen internal suspension of headpiece if needed (rotate external knob).

Grasp ear cushions with tips of thumbs (fig. 6-24), pull headpiece over head, and position ear cushions.

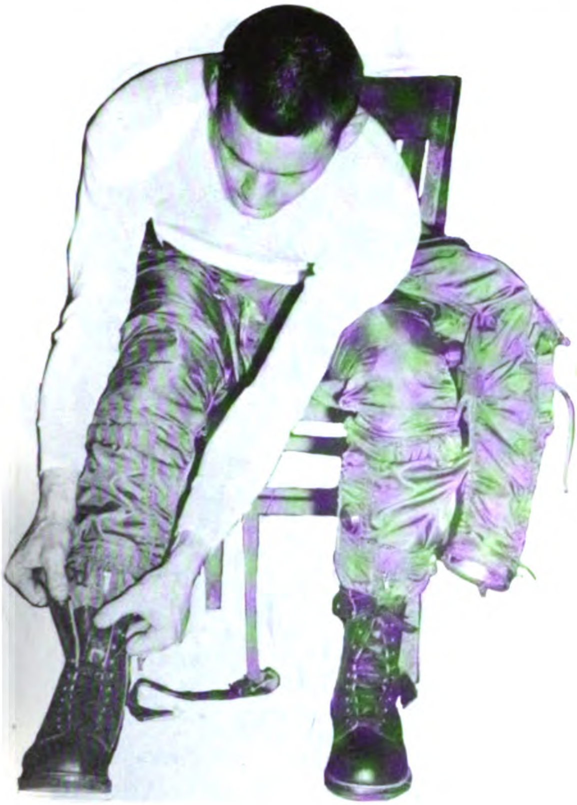


Figure 6-19.—Donning and adjusting boots.

Locate flexible face seal and conform to ymmetry of face.

Tighten suspension to effect face seal in-egrity by rotating external knob (fig. 6-25). A mental note of the number of rotations will nsure ease of doffing when applying a counter-lockwise rotation of the knob.)

Parachute Rigger locates locking mechanism hich is located (on neck bearing) slightly to ight of the pilot's chin.

Holding the helmet in position, he aligns nd inserts the base of the helmet into the nating groove on the neck bearing assembly. This can be best accomplished by placing the ight thumb over the edge of the lowermost ortion of the visor opening and extending the emaining fingers of that hand under the neck earing, at the same time placing the left thumb n the oxygen hose (near communication termi-als) and extending the remaining fingers of hat hand under the neck bearing. With the ands in this position exert a downward force, nd when the helmet is seated properly, engage the lugs by rotating the locking mechanism to front and center of the pilot's chin until the detent is engaged.

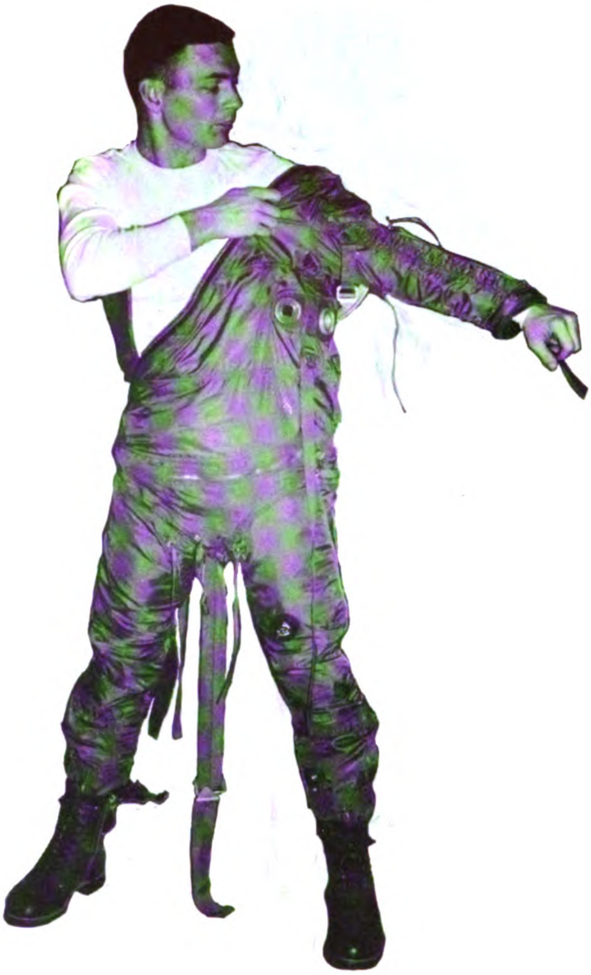


Figure 6-20.—Inserting arm through arm section.

CAUTION: In securing the headpiece to the neck bearing, care should be taken not to displace the O-ring. A very light film of silicone lubricating grease placed on the O-ring facilitates mating.

Insert hands into gloves and adjust for comfort.

Parachute Rigger engages and only starts zipper.

Parachute Rigger engages disconnect, making sure that the O-ring is not displaced in the process.

Parachute Rigger completes closure of the disconnect zipper.

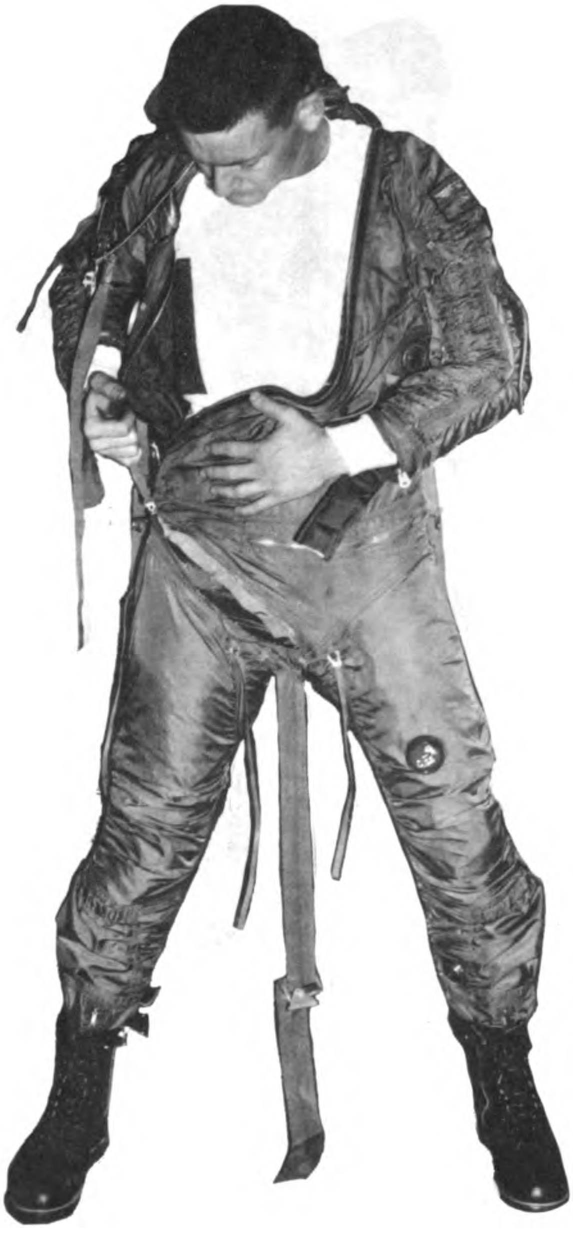


Figure 6-21.—Opening waist gusset zipper.

Adjust and fasten wrist strap.

Adjust palm restraint (if needed).

Parachute Rigger connects hose fittings to the torso, making sure that the nozzles are secure in suit fittings.

Parachute Rigger helps the pilot to step into the harness, and pulls the harness up on the pilot's shoulders, as shown in figure 6-26, closes the zipper on the flotation garment, then attaches the cross chest harness, and adjusts for proper snugness.

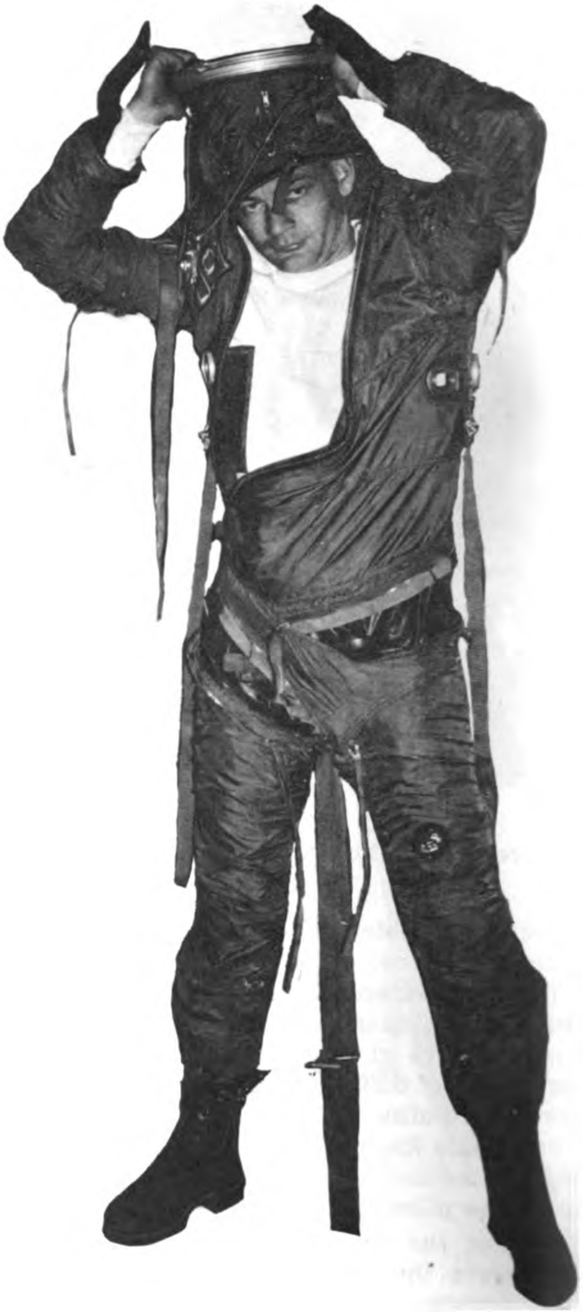


Figure 6-22.—Inserting head through neck section.

Preflight Assistance

After the pilot enters the cockpit he should adjust his torso tiedowns to their predetermined markings. The PR should then assist in attaching

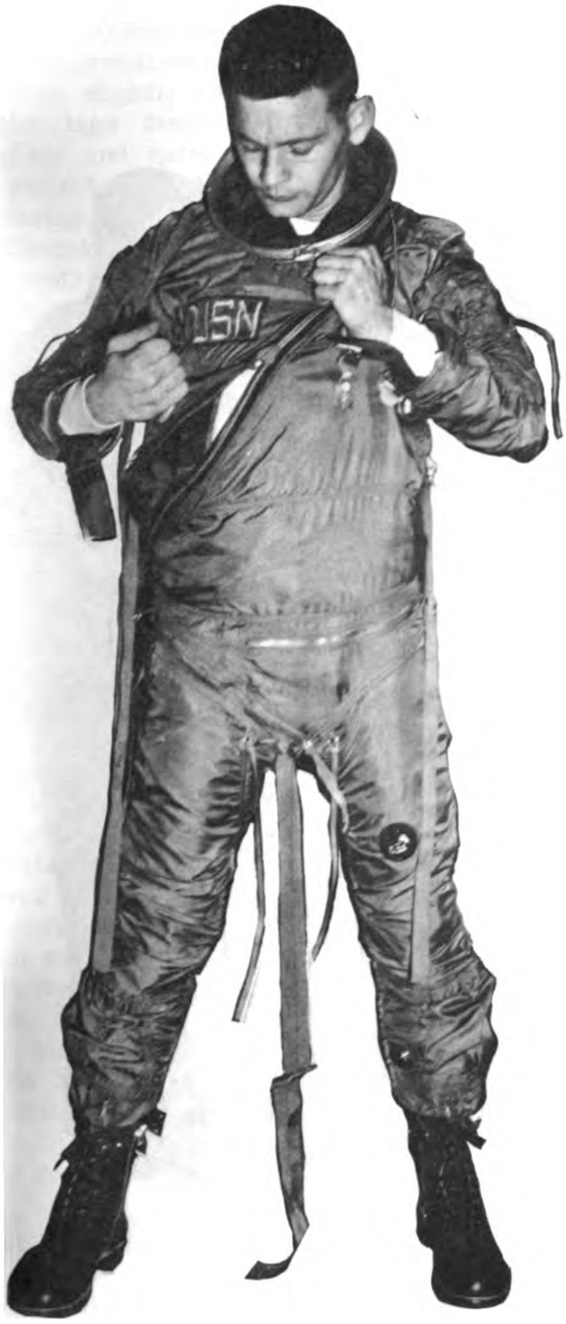


Figure 6-23.—Closing the entrance zipper.

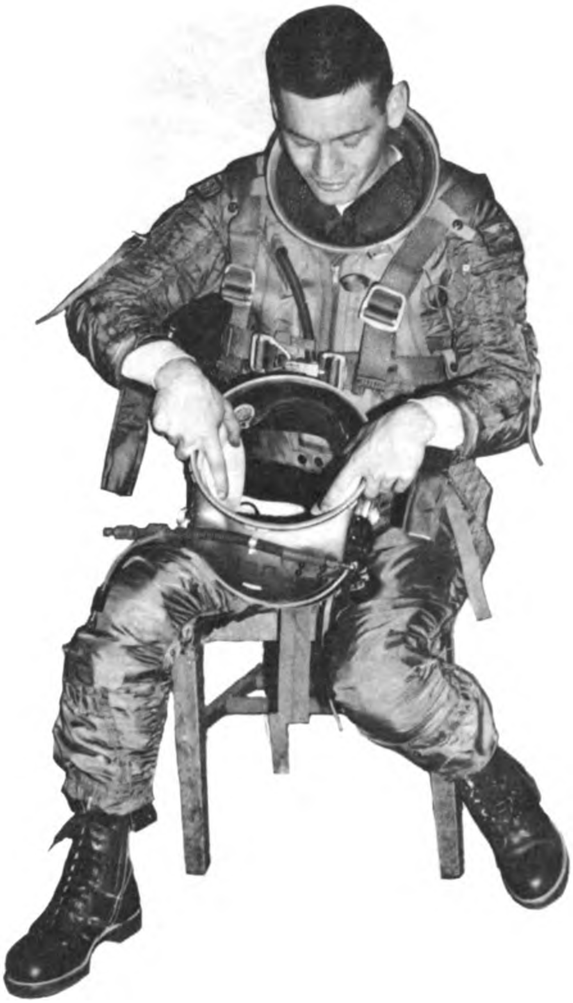


Figure 6-24.—Spreading earcups.

he parachute, inertia reel, and seat belt to the arness, and assist in connecting the services rom the aircraft to the suit, making certain hat the GR-90 regulator is in the OFF posiion before turning on the aircraft oxygen upply. Check for operation, pressure, and uantity. Pull the pin on the bailout unit only if the aircraft is equipped with the warning system for automatic bailout. The pilot is now ready to close his visor, turn on his breathing oxygen and ventilation air, and check his communications system.

Postflight Procedure

On landing, the pilot usually has his breathing oxygen and ventilation air turned off and his visor open. In such an event, render assistance in releasing the parachute, inertia reel, lap belt, tiedown, and also the connecting services from aircraft to suit.

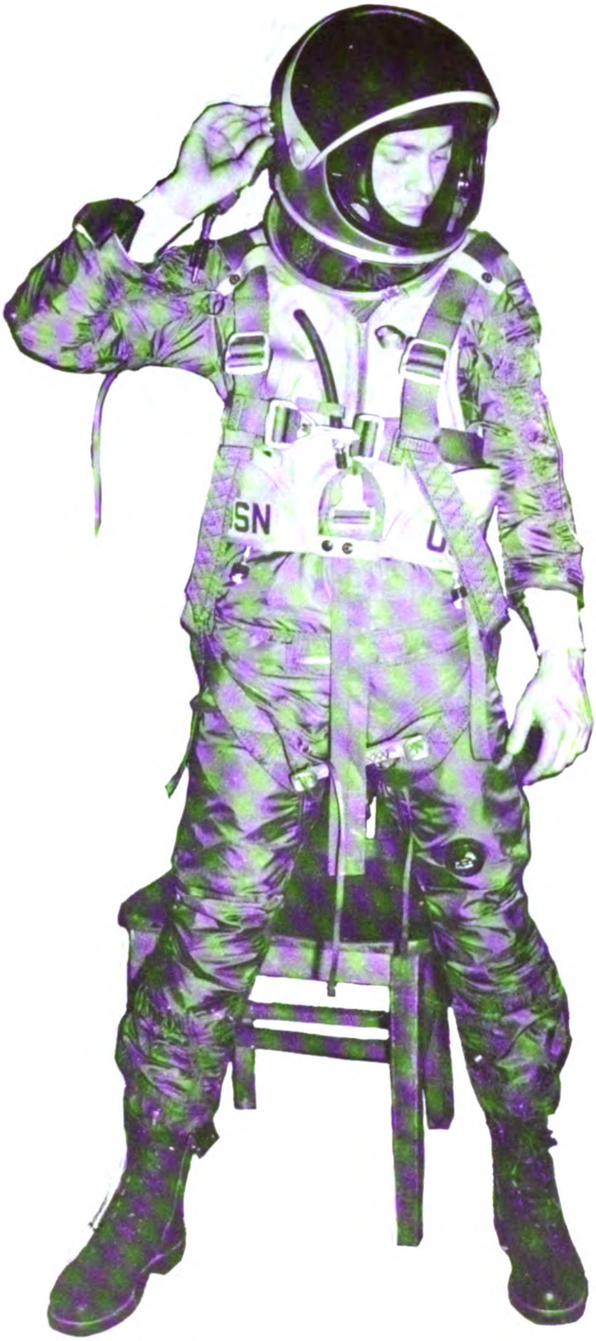


Figure 6-25.—Effecting an airtight seal.

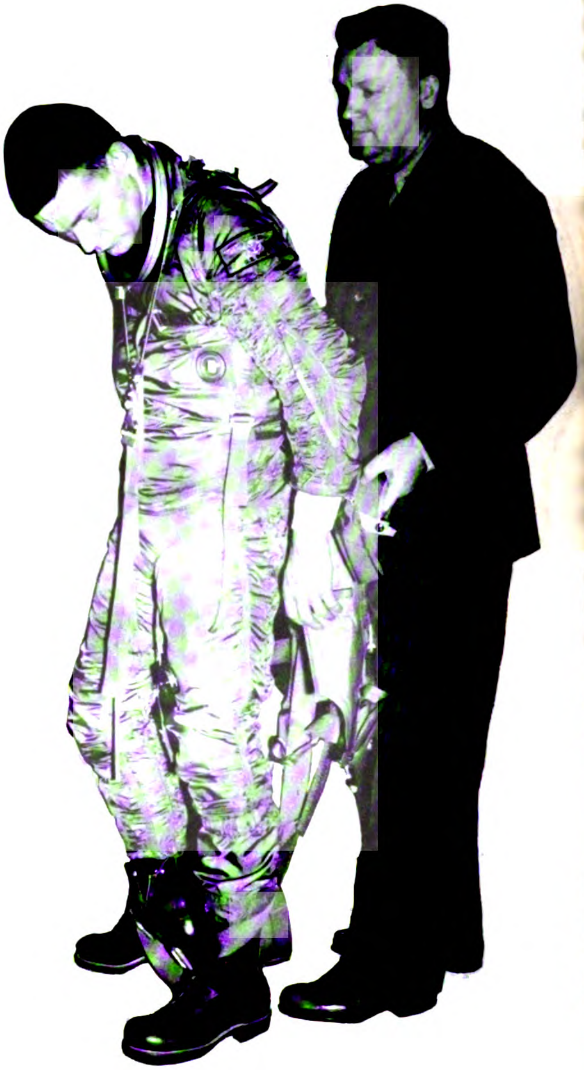


Figure 6-26.—Parachute Rigger assisting in donning of flotation garment and harness.

Doffing Procedure

The following procedure, with assistance as required, is recommended for simplification and ease of doffing the suit system:

1. Parachute Rigger disconnects and removes hose nozzles from the suit port fittings.

2. Remove flotation garment and harness assembly with Parachute Rigger assistance.

3. Disengage headpiece by releasing the etent in the locking mechanism on neck bearing. his is accomplished by rotating the locking echanism slightly to the right of the chin. ith the lugs disengaged, hold the locking echanism and move the head upward. This ction should separate the headpiece from the eck bearing.

4. Disengage zippers on gloves, unsnap rist restraint, disengage disconnect, and emove gloves.

5. Parachute Rigger removes straps from uckles on rear tiedown assembly.

6. Open entrance zipper completely.

Open waist gusset zipper completely.

Open neck zipper and straps.

Grasp neck bearing with both hands, lift up, nd at the same time depress head slightly nd move forward and out of neck section.

7. With the right hand, grasp the chest trap and pull outward. (This action should emove the shoulder cap of the suit from the an's shoulder.)

Now locate the right arm in the area of the mall of the back and with the left hand rasp the sleeve of the right arm and remove ight arm from suit.

Remove left arm from suit section and lose waist gusset zipper.

Lower suit to area of knees.

Remove boots.

Open ankle zippers.

Remove suit completely.

Upon removal of suit, Parachute Rigger hould insert a clothes hangar through the ntrance zipper into the neck section, close he entrance zipper, to within two inches of eing fully closed, and hang the suit in the torage area to ventilate and dry.

PREVENTIVE CARE AND MAINTENANCE

If the full pressure suit is to operate as ntended, it is necessary that ground personnel nsure that preventive maintenance be performed ith care.

Underwear

During use, the underwear may become ampened by perspiration. It should be laundered as needed. It may be laundered in an utomatic washer or by hand, using warm water and a mild soap. It should be hung to dry or tumble dried in an automatic drier with only warm air. Rapid drying may cause excessive shrinkage. If the Trilok screens are adhered to the garment by use of "Velcro" tape, the screens should be removed before laundering and replaced after the garment is dry.

Anti-g Suit

The cutaway anti-g suit should be cared for in the same manner as the standard anti-g suit. Bladders should be periodically inflated and checked for leakage, and the inlet connection should be checked to make sure it makes proper connection with the anti-g suit port fitting.

Torso

Extreme care should be exercised at all times with the torso section. Care should be taken to eliminate sharp projections which could puncture or snag the torso in all areas where suits are handled or worn.

A periodic visual inspection should be made on all torso components and should include the following important points.

The outer garment should be free of snags and should not show excessive wear.

The neck bearing should turn freely. Several drops of Dow Corning 510 silicone fluid should be applied between the races periodically. This can be readily accomplished by injecting a hypodermic needle containing the fluid in the recess found on the underside of the neck bearing. With an accumulation of grit or wear, a resistance of the bearing to rotate freely may be encountered. When this occurs, the bearing must be disassembled and cleaned as follows: Remove the retaining ring lock screw, retaining ring, backup ring, quad ring, and Teflon seal. Being very careful, separate the inner and outer race and remove the ball bearings. Clean the balls with Freon 113 and dry thoroughly. Install the ball bearings in the inner race groove. (The correct number of balls is 111 red nylon spacer bearings 0.122" dia. and 111 steel ball bearings 0.125" dia.) Reassemble the bearing in reverse order of disassembly.

The pressure sealing entrance zipper and relief zipper should be inspected for tears in the rubber sealing lips and loose or missing zipper teeth, and should be free of dirt or other residuals. The zipper sliders should operate freely. A light film of silicone grease, Spec. MIL-L-4343A (Dow Corning type 33 silicone grease) should be applied to the rubber zipper lips periodically as needed to give easy operation.

All port fitting nozzles and plugs should lock and unlock freely.

A visual inspection should be made by the PR prior to all pressure suit flights and should be followed by a ground level pressurization of the entire suit (empty) prior to donning. The suit should be pressurized to 3.0 p.s.i. and the leakage rate determined. The leakage rate must not exceed 20 l.p.m. Boots must enclose the sock ending whenever the torso is pressurized. On occasion the suit should be pressurized between 3.5 and 4.0 p.s.i. in order to test the "popoff" characteristics of the pressure relief valve. Two of the most critical areas of the torso are the pressure sealing entrance zipper and the relief zipper in the front crotch area. Avoid excessive pulling when opening and closing the zipper sliders, and take care that no straps or fabric become jammed in these zippers.

Whenever opening or closing zippers, take care that the suit plies do not get caught under the slider or between zipper teeth.

Take care not to strike the neck bearing with anything. It may be knocked out of round, making it difficult to turn.

Do not permit the wearer to apply too much force to the stretchable sock ending during donning or removal.

After wear, always dry and ventilate the torso, gloves and helmet before storage.

It is suggested that the torso be hung on a clothes hanger extended through the neck section. The entrance zipper should be closed within two inches of the closed end seals so that the slider does not rest on the end seal.

If the suit is immersed in salt water, it should be worn into a fresh water shower to remove brine.

Gloves

The gloves should be inspected periodically to make sure that there are no obvious tears or cuts. Check the zipper for damaged or missing teeth. Make sure the O-ring is not damaged and that the O-ring is lubricated. An occasional application of a good leather dressing, such as Neatsfoot oil, to the leather will keep it soft and pliable after wetting.

Shoes

Shoes should be cared for like any good footwear. They should be inspected periodically for obvious damage or excessive wear. Also keep good laces in the boots.

Flotation Garment

The garment should be cared for in the same manner as a standard inflatable life preserver. It should be inflated periodically and checked for leaks in the bladders. A visual inspection should be made for completeness of assembly and any indication of obvious damage.

For any prolonged storage it is suggested that the garment be partially inflated in an extended position to prevent sharp creases in the bladders.

Evacuate as much air as possible from the bladders. Any trapped air expands at high altitudes and will partially inflate the garment.

Helmet

The helmet should be handled carefully at all times. A plastic carrying case is provided with each helmet, and it is recommended that the helmet be kept in its carrying case when not in use. The sponge face seal should be handled carefully during donning and doffing to prevent tearing the soft sponge. The metal ring at the base of the helmet should be protected from bumps or rough handling which may damage it and prevent proper engagement with the neck bearing.

CAUTION: Never use the oxygen hose for a handle. This hose contains communication system wiring which could be damaged by rough handling.

The plastic visor and tinted lens should be cleaned as needed. Use only a nonabrasive soap and clean water to remove dirt. Grease may be removed with hexane, kerosene, or white gasoline. Use only a soft cloth to apply the cleaning agent. Never rub the surface with any abrasive. Keep aromatic fuels away from the visors as they may cause surface crazing.

Antifogging solution is recommended for use on the visor to prevent fogging. Use care in applying a thin film with cotton swab to avoid scratching the plastic visor. Lightly remove excess after drying for a few minutes. Leave he oxygen regulator ON-OFF button in ON position, when not in use, to avoid permanent set in shutoff O-ring inside regulator.

A periodic check of the helmet should be made for obvious damage and should include a check of the following areas:

Clear and tinted visors not cracked or scratched.

Visors should raise and lower freely, and button latches should operate easily.

Face seal not damaged.

Communications wire connections secure.

Oxygen hose connection tight.

Microphone swivel secured enough to hold position.

Windup adjustment knob should be tight on shaft.

Inflatable seal should hold pressure for at east 30 minutes after shutoff of oxygen supply.

Helmet O-ring should not be damaged.

Helmet should make tight seal when attached o torso neck bearing. Check this during eakage test.

Mk IV Life Preserver

The life preserver portion of the flotation garment should be cared for and inspected in he same manner as standard inflatable life preservers. It should be inflated periodically and checked for leaks in the bladders. Residual ir should be evacuated as much as possible before wear to reduce expansion at high altitudes.

General

All pressure suit equipment should be stored in an area free from dust and dirt and away from excessive heat.

The suit should be dried and ventilated after each wearing.

Avoid smoking while handling or wearing the suit. A spark could melt a hole in the suit fabric. When 100 percent oxygen is being used, a fire hazard is also present.

TESTING

Suit Leakage Test

The pressure suit portable test kit shown in figure 6-27 is required to test the pressure suit for leakage. Figure 6-28 shows a schematic diagram of the test kit, and figure 6-29 is a

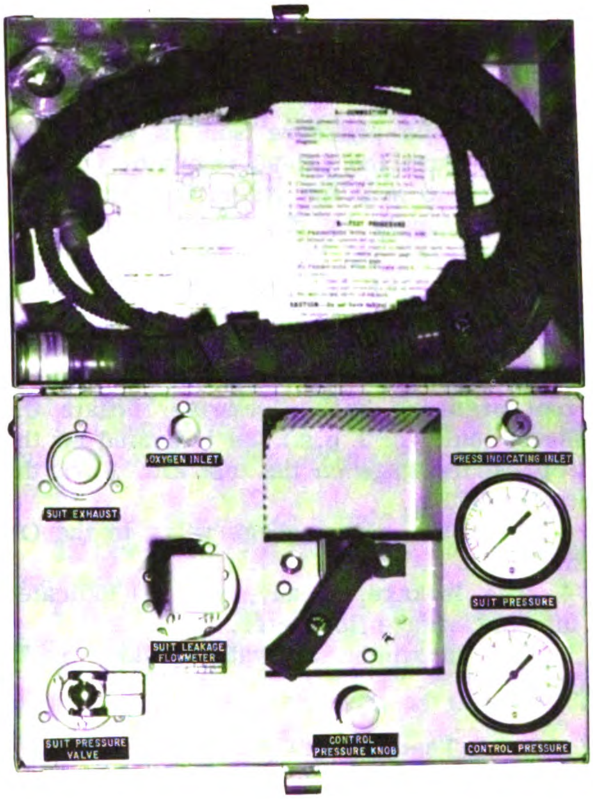


Figure 6-27.—Pressure suit portable test kit.

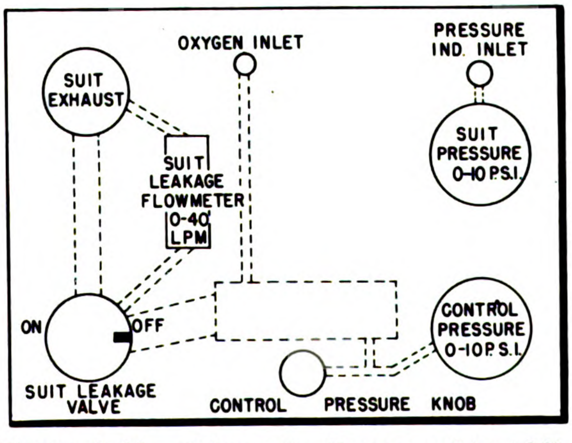


Figure 6-28.—Schematic diagram of test kit.

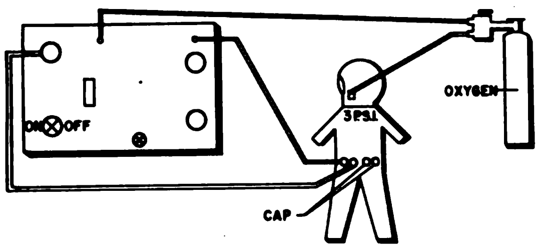


Figure 6-29.—Schematic of test setup.

schematic of the test setup. The test procedure is as follows:

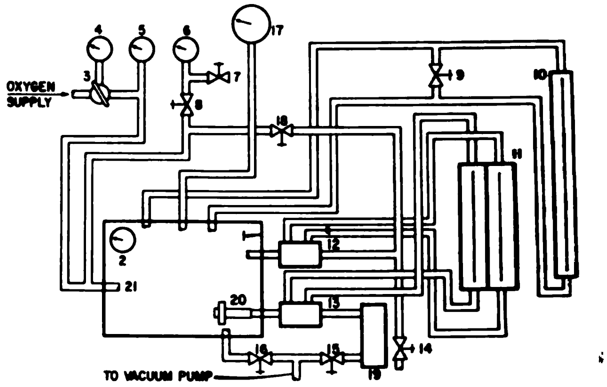
1. After the pressure suit is set up as illustrated, turn the GR-90 regulator ON just long enough to seal the visor, then turn OFF the oxygen supply by disconnecting the hose at the reducer. DO NOT move the regulator button to the OFF position. The suit can be inflated with oxygen through the regulator, but it is a waste of oxygen and a slower process.
2. Turn the air valve ON, and by adjusting the control pressure knob clockwise, inflate the pressure suit to 3 p.s.i. as indicated on the suit pressure gage on the test kit. Turn the air valve OFF.
3. Turn the suit leakage valve to the ON position.
4. The leakage, if any, will be indicated on the suit leakage flowmeter.
5. The maximum allowable leakage is 20 l.p.m.

Testing Suit Components

The components of the full pressure suit are to be tested every 30 days. These tests are to be performed on the OTS-565 test stand which has been modified in accordance with NavAer 17-15BC-505 (Revised 1959).

MODIFYING THE OTS-565 TEST STAND.—A kit is available for making the following changes (fig. 6-30):

1. Oxygen line tapped into the supply source which flows into the chamber through the input Vol-O-Flo element. This is used to check the exhalation valve of the regulator to the headpiece.
2. A 100,000-foot altimeter for attaining higher altitudes than the limits of the aircraft altimeter equipped with the test stand.
3. Surge (ballast) tank to permit an even rise and fall of the pressure-suction manometer.



1. Altitude chamber.
2. Chamber altimeter (60,000 ft.).
3. Oxygen pressure reducer.
4. Gage, high-pressure (4,000 p.s.i.).
5. Gage, high-pressure (3,000 p.s.i.).
6. Gage, low-pressure (200 p.s.i.).
7. Pressure relief valve, Hoke, 560.
8. Oxygen gage low-pressure cutoff valve, Hoke, 304.
9. Valve, Hoke, P450.
10. Pressure-suction manometer.
11. Manometer (input and output Vol-O-Flo).
12. Input Vol-O-Flo element.
13. Output Vol-O-Flo element.
14. Inlet valve.
15. Outlet valve.
16. Bypass valve.
17. Altimeter (100,000 ft.).
18. Valve, Hoke, D336M.
19. Ballast tank.
20. Piezometer ring.
21. Oxygen inlet.

Figure 6-30.—Schematic of modified OTS-565 test stand.

4. Piezometor ring with the aircraft altimeter attached.

NOTE: All valves must be closed at the onset of each test.

DEMAND VALVE LEAKAGE TEST.—The piping setup for performing the demand valve leakage test is shown in figures 6-30 and 6-31. The test procedure is as follows:

1. Connect the suit controller to the test chamber oxygen inlet by means of the oxygen fitting. This test is performed under sea level conditions.
2. Open the oxygen supply valve.
3. Open the oxygen gage low-pressure cutoff valve.

4. Adjust the oxygen pressure by means of he pressure reducer to read 70 p.s.i.

5. There must be no leakage from the suit xhaust air inlet nor from the exhaust outlet. This may be determined by listening and/or y soaping the ports.

6. At the end of the test close the oxygen upply valve (not shown).

7. Open the relief valve until the low- ressure gage reads zero.

8. Close the oxygen gage low-pressure cut- ff valve and the pressure reducer.

9. If leakage was tested by use of a soap olution, the controller must be immediately iped clean and dry to prevent corrosion. o not let soap solution enter the aneroid ompartment.

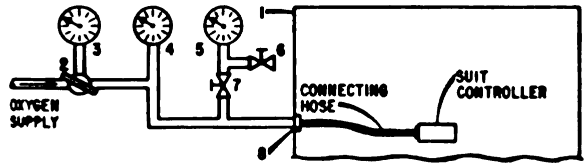
CONTROLLER CASE AND EXHAUST ALVE LEAKAGE TEST.—The setup for this est is shown in figures 6-30 and 6-31. The rocedure is as follows:

1. Connect the suit controller to the test tand oxygen inlet, by means of the oxygen itting. The chamber is not decompressed uring this test.

2. Open the oxygen supply valve.

3. Open the oxygen gage low-pressure cut- ff valve.

4. Adjust the oxygen pressure by means of he pressure reducer to read 5 p.s.i.



. Altitude chamber.
. Oxygen pressure chamber.
. Gage, high-pressure (4,000 p.s.i.).
. Gage, high-pressure (3,000 p.s.i.).
5. Gage, low-pressure (200 p.s.i.).
6. Relief valve.
7. Oxygen gage low-pressure cutoff valve.
8. Oxygen inlet.

Figure 6-31.—Schematic of the test setup for the demand valve, controller case, and the exhaust valve leakage test.

5. Cap the suit exhaust air inlet to prevent flow of air.

6. Remove the screen covering the aneroid compartment relief port. Place a rubber stopper on this port and hold in place with a C-clamp, taking care not to damage the controller. Keep the port closed throughout the test and hold for at least 10 minutes before checking for leakage.

7. Check case and controller exhaust port for leakage by listening and/or by soaping.

8. There shall be no leakage.

9. At the end of the test close the oxygen supply valve.

10. Open the relief valve until the low-pressure gage reads zero.

11. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

ANEROID COMPARTMENT VENT ORIFICE TEST FOR REQUIRED BLEED.—The setup for this test is shown in figure 6-30. The procedure is as follows:

1. Connect the suit controller to the test chamber oxygen inlet, by means of the oxygen fitting.

2. Open the oxygen supply valve.

3. Open the oxygen gage low-pressure cutoff valve.

4. Adjust the oxygen pressure by means of the pressure reducer to read 70 p.s.i.

5. Attach a hose to the 400 cc./min. rotameter (not shown) which is provided on the face of the test stand.

6. Hold this hose over the aneroid compartment relief port in such a manner that the hose will transfer the oxygen from the bleed port to the rotameter without leakage.

7. There shall be a flow of 100 to 150 cc./min. indicated on the rotameter.

8. At the end of the test close the oxygen supply valve.

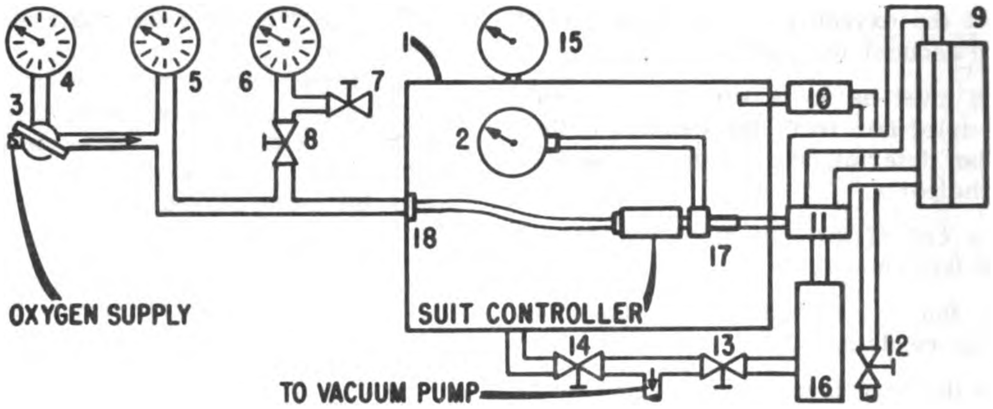
9. Open the relief valve until the low-pressure gage reads zero.

10. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

SUIT CONTROLLER HOLD TEST.—The setup for this test is shown in figures 6-30 and 6-32. The procedure is as follows:

1. Connect the suit controller to the test chamber oxygen inlet, by means of the oxygen fitting.

2. Connect the suit exhaust air inlet to the inlet of piezometer ring. Make certain the



1. Altitude chamber.
2. Altimeter (60,000 ft.).
3. Oxygen pressure reducer.
4. Gage, 4,000 p.s.i.
5. Gage, 3,000 p.s.i.
6. Gage, 200 p.s.i.
7. Relief valve.
8. Oxygen gage LP cutoff.
9. Manometer (Vol-O-Flo).
10. Input Vol-O-Flo element.
11. Output Vol-O-Flo element.
12. Inlet valve.
13. Outlet valve.
14. Bypass valve.
15. Altimeter (high altitude).
16. Ballast tank.
17. Piezometer ring.
18. Oxygen inlet.

Figure 6-32.—Schematic of test setup for the suit controller hold test and the test for the controller's ability to compensate for suit leakage.

piezometer ring is attached, as in the diagram, to the output Vol-O-Flo.

3. Connect (by means of a hose) the static pressure tap of the piezometer ring to the inlet of the chamber altimeter.

4. Open the oxygen supply valve.

5. Open the oxygen gage low-pressure cutoff valve.

6. Adjust the pressure reducer until 70 p.s.i. is indicated.

7. Start the vacuum pump.

8. Close the chamber with the cover glass.

9. Open the bypass valve to evacuate the chamber at the rate of about 10,000 ft./min.

10. Level the chamber at an altitude of 40,000 feet as indicated on the high-altitude altimeter. The inlet valve can be opened slightly if it is necessary to lower the chamber altitude when leveling at 40,000 feet.

11. When the high-altitude altimeter is stabilized at 40,000 feet, the chamber altimeter should indicate an altitude no lower than 34,500 feet nor higher than 36,500 feet.

12. If the chamber altimeter indicates the required altitude, close the inlet valve and open the bypass valve to evacuate the chamber to an altitude of 70,000 feet.

13. Stabilize the chamber altitude at 70,000 feet.

14. The chamber altimeter should indicate an altitude no lower than 34,500 feet nor higher than 36,500 feet.

15. At the end of the test, close the bypass valve and open the inlet valve to allow the chamber altitude to drop to ambient at the rate of 10,000 ft./min.

16. When the chamber altitude is at sea level, remove the cover glass and shut off the vacuum pump.

17. Close the inlet valve.

18. Close the oxygen supply valve.

19. Open the relief valve until the low-pressure gage reads zero.

20. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

TEST FOR CONTROLLER'S ABILITY TO COMPENSATE FOR SUIT LEAKAGE.—The setup for this test is shown in figures 6-30 and 6-32. The procedure is as follows:

1. Connect the suit controller to the chamber oxygen inlet.

2. Connect the suit exhaust air inlet to the nlet of piezometer ring. Make certain the iezometer ring is attached as in the diagram, o the output Vol-O-Flo.

3. Connect (by means of a hose) the static ressure tap of the piezometer ring to the nlet of the chamber altimeter.

4. Open the oxygen supply valve.

5. Open the oxygen gage low-pressure cut-ff valve.

6. Adjust the pressure reducer until 70 .s.i. is indicated.

7. Start the vacuum pump.

8. Close the chamber with the cover glass.

9. Open the bypass valve to evacuate the hamber at the rate of about 10,000 ft./min.

10. Stabilize the altitude of the chamber at 0,000 feet as indicated on the high-altitude ltimeter. The inlet valve can be opened and djusted to maintain the altitude of the chamber t 60,000 feet if necessary.

11. With the chamber stabilized at 60,000 eet, the altitude indicated on the chamber ltimeter should be no lower than 34,500 nor igher than 36,500 feet. Note the altitude ndicated.

12. Open the outlet valve until a flow of 0 l.p.m. is indicated on the output Vol-O-Flo nanometer. (Actual l.p.m. is in reference to he altitude indicated on the chamber altimeter.)

13. When a flow of 60 l.p.m. is indicated, he altitude indicated on the chamber altimeter hould be noted.

14. The altitude on the chamber altimeter ith a flow of 60 l.p.m. shall not be greater han 38,000 feet.

15. At the end of the test, close the outlet alve.

16. Close the bypass valve.

17. Open the inlet valve to allow the chamber ltitude to drop at the rate of 10,000 ft./min.

18. When the chamber altitude is at sea evel, remove the cover glass and shut off the acuum pump.

19. Close the inlet valve.

20. Close the oxygen supply valve.

21. Open the relief valve until the low-ressure gage reads zero.

22. Close the oxygen gage low-pressure cut-ff valve and the pressure reducer.

BREATHING REGULATOR.—The setup for his test is shown in figure 6-33. The procedure s as follows:

1. Clamp the test fixture to the face seal in the helmet.

2. Connect hose from the largest outlet (3/4 I.D.) of the fixture to the output Vol-O-Flo.

3. Connect hose from one of the smaller outlets of the fixture to the bottom of the pressure-suction manometer.

4. Block all other ports from the fixture.

5. Connect the breathing regulator oxygen inlet to the test stand oxygen inlet.

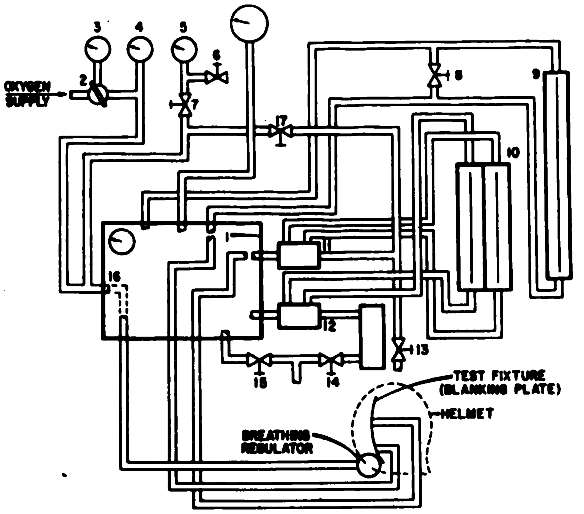
6. Open the oxygen supply valve.

7. Open the oxygen gage low-pressure cut-off valve.

8. Adjust the oxygen pressure by means of the pressure reducer to read 70 p.s.i.

9. Turn the breathing regulator button to ON with clear visor closed.

10. The pressure-suction manometer should read between 1/2 to 1 1/2 inches of water pressure.



1. Altitude chamber.
2. Oxygen pressure reducer.
3. Gage, 4,000 p.s.i.
4. Gage, 3,000 p.s.i.
5. Gage, 200 p.s.i.
6. Relief valve.
7. Oxygen gage LP cutoff.
8. Valve, Hoke.
9. Pressure-suction manometer.
10. Manometer (Vol-O-Flo).
11. Input Vol-O-Flo element.
12. Output Vol-O-Flo element.
13. Inlet valve.
14. Outlet valve.
15. Bypass valve.
16. Oxygen inlet.

Figure 6-33.—Schematic of test setup for testing the GR-90 breathing regulator.

11. Open the outlet valve (with pump on) until the output manometer indicates 100 l.p.m.

12. The pressure-suction manometer should indicate a pressure at least slightly above zero.

13. Close the outlet valve.

14. Slide regulator button to OFF position.

15. Close the oxygen supply valve.

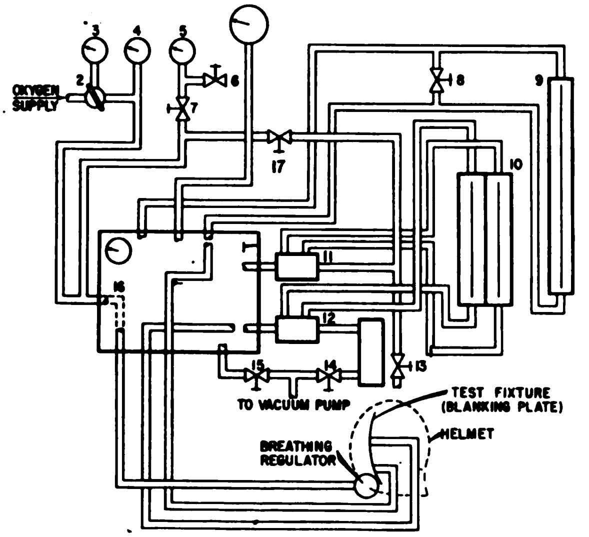
16. Open the relief valve until the low-pressure gage reads zero.

17. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

18. Shut off the vacuum pump.

EXHALATION VALVE.—The setup for this test is shown in figure 6-34. The procedure is as follows:

1. Clamp the test fixture to the face seal in helmet.



1. Altitude chamber.
2. Oxygen pressure reducer.
3. Gage, 4,000 p.s.i.
4. Gage, 3,000 p.s.i.
5. Gage, 200 p.s.i.
6. Relief valve.
7. Oxygen gage LP cutoff.
8. Valve, Hoke, P450.
9. Pressure-suction manometer.
10. Manometer (Vol-O-Flo).
11. Input Vol-O-Flo element.
12. Output Vol-O-Flo element.
13. Inlet valve.
14. Outlet valve.
15. Bypass valve.
16. Oxygen inlet.
17. Valve, Hoke, D336M.

Figure 6-34.—Schematic of test setup for testing the exhalation valve.

2. Connect hose from the largest outlet (3/4 I.D.) of the fixture to the input Vol-O-Flo.

3. Connect hose from one of the smaller outlets of the fixture in the bottom of the pressure-suction manometer.

4. Block all other ports from the fixture.

5. Connect the breathing regulator oxygen inlet to the test stand oxygen inlet.

6. Open the oxygen supply valve.

7. Open the oxygen low-pressure cutof valve.

8. Adjust the oxygen pressure by mean of the pressure reducer to read 70 p.s.i.

9. Turn the breathing regulator button t ON with visor closed.

10. Readjust inlet pressure to read 15 p.s.i.

11. The pressure-suction manometer shoul read between 1/2 to 1 1/2 inches of wate pressure.

12. Check the exhalation valve for leakage. There should be none.

13. Close the pressure reducer and ope the relief valve (keep regulator button in O position).

14. When zero pressure is indicated on th low-pressure gage, disconnect hose from oxyge inlet.

15. Block the oxygen inlet.

16. Open the pressure reducer until 10 p.s.i is indicated.

17. Open valve (17, fig. 6-34) until 90 l.p.m is indicated on the input manometer.

18. The pressure indicated on the pressure-suction manometer should be no greater tha 2.5 inches of water.

19. Close valve (17).

20. Slide regulator button to OFF positio

21. Close the oxygen supply valve.

22. Open the relief valve until the low pressure gage reads zero.

23. Close the oxygen gage low-pressur cutoff valve and the pressure reducer.

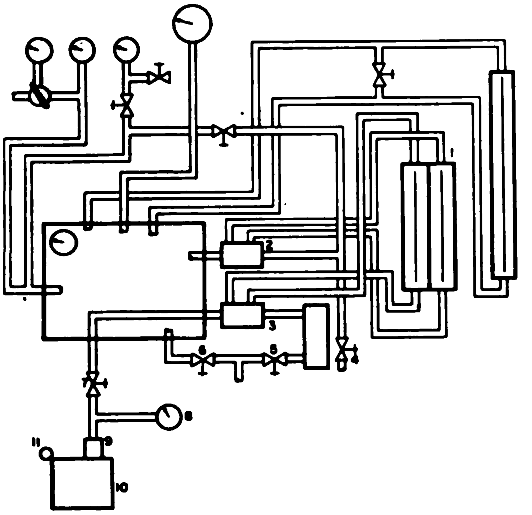
BAILOUT UNIT REDUCER.—The setup fo this test is shown in figure 6-35. The procedur is as follows:

1. Connect hose from the output Vol-O-Fl to shutoff valve (7, fig. 6-35).

2. Connect with hose (150 p.s.i. test pressure) from this valve to a 0 to 100 p.s.i gage (8) and from this gage to the emergenc cylinder reducer.

3. Open the output and bypass valves.

4. Cylinder gage should read 1,800 p.s.i.



1. Manometer (Vol-O-Flo)
2. Input Vol-O-Flo element.
3. Output Vol-O-Flo element.
4. Inlet valve.
5. Outlet valve.
6. Bypass valve.
7. Shutoff valve.
8. Gage, 0 to 100 p.s.i.
9. Emergency reducer.
10. Emergency cylinder.
11. Cylinder gage.

Figure 6-35.—Schematic of test setup for testing the emergency reducer.

5. Make certain valve (7) is closed.
6. Actuate reducer.

7. The 0 to 100 p.s.i. gage should read etween 40 and 60 p.s.i.
8. Open valve (7) until output manometer dicates 140 l.p.m.
9. The 0 to 100 p.s.i. gage should read etween 40 and 60 p.s.i.

10. Keep valve open until cylinder gage is own to 250 p.s.i.
11. The 0 to 100 p.s.i. gage should continue o read between 40 and 60 p.s.i.

12. When the cylinder gage reads 250p.s.i., lose valve (7).
13. The 0 to 100 p.s.i. gage should read etween 40 and 60 p.s.i.
14. Lock reducer.
15. Close the output and bypass valves and isconnect emergency reducer.

MISCELLANEOUS PERSONAL EQUIPMENT

In addition to fitting and maintaining full pressure suits and instructing others in their use, leading Parachute Riggers are responsible for fitting and adjusting anti-g suits, fitting and modifying oxygen masks, and instructing lower rated men in fitting helmets, anti-exposure suits, integrated torso harness suits, and other types of flight and protective clothing and equipment.

Flight clothing is indexed under Federal Stock Group 84, and allowances authorized for aircraft squadrons are contained in Section H of the Bureau of Naval Weapons *Allowance List.* As a leading Parachute Rigger, you must be familiar with the dozens of items authorized for use by your outfit and be fully qualified to fit, adjust, repair, and make authorized modifications to these items, as well as instruct others in their use.

Anti-g Suits

Anti-g equipment is currently installed in high-performance aircraft to counteract the effects of prolonged acceleration on the pilot. The ill effects of such acceleration range from excessive fatigue and decreased alertness to blackout and unconsciousness.

EFFECTS OF ACCELERATION.—It is generally stated in relation to anti-g suits, that for each unit corresponding to the pull exerted by the earth's gravitational field, the force of inertia in acceleration is proportional to the square of the velocity and inversely proportional to the radius of the turn. For example, at 5 g.'s the pilot's body is exposed to a force of inertia which increases its weight and that of its components 5 times.

Grayout and blackout are physiological anoxic states directly related to the diminished blood volume reaching the eye and higher cerebral centers during and following periods of high acceleration. During these periods, the blood tends to pool in the blood vessels of the legs and abdomen, thus diminishing the amount of blood returning to the heart, and the cardiac output is therefore reduced. Thus, grayout and blackout with disturbances in the state of consciousness are merely symptoms of successive steps of anoxia of the brain. These symptoms are directly proportional to the amount of g.'s, the reduced cranial blood supply, and the length of time these factors are acting.

Without anti-g coveralls, the average pilot can withstand 4.5 to 5.5 g.'s. without losing vision or blacking out. With anti-g coveralls, the average pilot is capable of withstanding 6.0 to 7.0 g.'s. This protection is available only for sustained accelerations of 4 to 5 seconds or longer in maneuvers other than snap maneuvers. It is emphasized that the anti-g equipment does not offer protection in snap maneuvers where 10 to 12 g.'s can be applied in approximately 1 second.

FITTING THE ANTI-G SUIT.—Anti-g coveralls are furnished in the following types: Type Z-2, or full garment, and type Z-3, or cutaway garment. (See fig. 6-36.) The Z-2, which is available in 11 sizes, resembles a standard summer flying suit; while the Z-3 is a skeleton type and is available in 4 sizes. Both types have 5 interconnected bladders which are attached to the air pressure source with a single quick-disconnect hose. These coveralls provide a range of from 1.0 to 2.0 g. protection against blackout, depending on the type of coveralls, variations in the tightness of fit, and whether the HIGH or LOW setting on the anti-g pressure regulating valve is used.

Another feature of the anti-g valve is the pushbutton at the top which may be operated manually to test the anti-g equipment on the ground or in level flight. Prior to each flight, the Parachute Rigger should make certain the pilot depresses this button to check the operation of the system. This feature also makes possible the inflating of the coveralls in long flights from time to time in order to relieve venous congestion of the legs and stiffness and tension of the body by a massaging effect of the inflating bladders.

In the initial fitting of the anti-g coverall, the decisions revolve around the correct choice of fit which is that of selecting the proper size. However, everyone's measurements do not conform with standard size requirements. The coverall should fit snugly, especially at the waist.

The flight surgeon, aided by a Parachute Rigger, is responsible for fitting and instructing

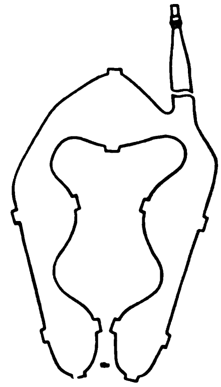


Figure 36 (B).—Anti-g suit, internal bladder arrangement.

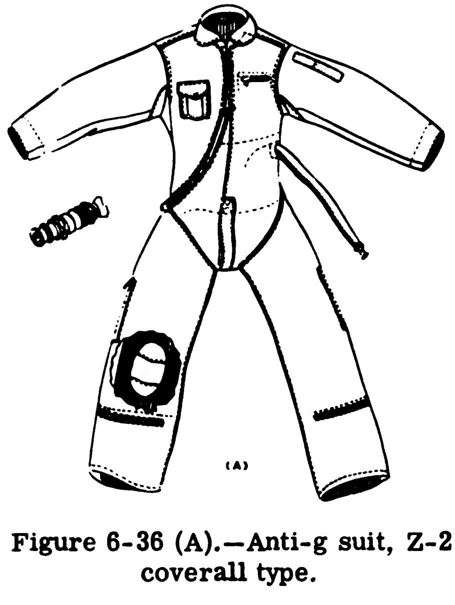


Figure 6-36 (A).—Anti-g suit, Z-2 coverall type.

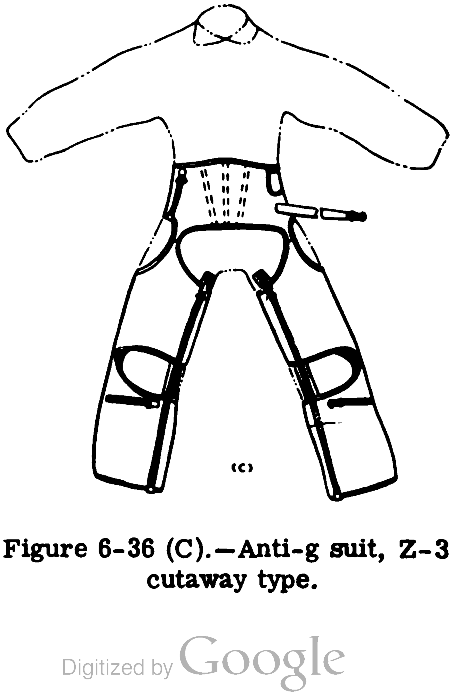


Figure 6-36 (C).—Anti-g suit, Z-3 cutaway type.

personnel. If there are any doubts about the fit, the pilot should sit in a simulated position as in the aircraft, and inflate the coveralls orally. The bladders should compress the waist, calves, and thighs firmly and evenly. If difficulty is encountered in properly fitting the coverall legs, zipper inserts, which are available to increase the leg sizes, may be used in the Z-2 garment. If the pilot has difficulty in getting coveralls with legs small enough, the Parachute Rigger may have to tailor the legs. This is accomplished by taking in all the slack to insure a snug fit the full length of the legs. After marking this slack material with a suitable tailor's crayon, the legs are finished by sewing with a flat fell seam. Extreme care must be used when sewing on anti-g suits to prevent the needle from penetrating any one of the bladders. The Z-3 anti-g cutaway garment may be adjusted by the lacings provided on the garment.

USE OF THE EQUIPMENT.—All pilots of aircraft in which anti-g equipment is installed should wear the coverall type to become familiar with its functioning and advantages. It is particularly important that it be worn in the early stages of operational and gunnery training in fleet-type aircraft. It is on these flights that the pilot may miscalculate and pull excessive g.'s for a sufficient time to cause blackout or unconsciousness.

It is emphasized that anti-g equipment is effective in reducing fatigue under subblackout accelerations and especially so at high altitudes where factors of mild anoxia, lowered pressures, and acceleration may be cumulative. While high accelerations may not be encountered at high altitudes, the coveralls are still of considerable value for their antifatigue characteristics. Where higher accelerations are encountered, such as combat flight at lower altitudes, the anti-g equipment is even more important. Therefore, to improve combat preparedness and efficiency, the Parachute Rigger must make certain that all pilots concerned are thoroughly indoctrinated in the use of anti-g equipment.

The coveralls are not intended to take the place of the lifejacket, but will act as accessory flotation gear to provide extra flotation. Each coverall is equipped with an oral inflation valve which can be inserted into the end of the coverall inflation tube for oral inflation. In the event of a force-down at sea, instruct the pilot to unzip both legs by jerking upward on the quick release zipper fastenings on the upper thighs. Then, the plug is taken out of the left breast pocket and inserted into the disconnect. Next, the oral valve is unscrewed, and the wearer orally inflates the coveralls.

TEST AND MAINTENANCE.—To inspect for leaks, tears, or weakened fabric, the anti-g suit should be inflated to 5 p.s.i. The pressure must not fall below 4 p.s.i. in 30 seconds.

The coveralls should be laundered in lukewarm water, washed by hand, and never scrubbed or ironed. When not worn, the suit should be hung on a coathanger in a well-ventilated room.

A-13A Oxygen Mask

The A-13A pressure breathing oxygen mask consists of a facepiece, inhalation valve, pressure compensating exhalation valve, microphone port, harness assembly, and breathing tube assembly. Cleaning and maintenance of the components and installation of the ANB-M-C1 microphone are duties of lower rated Parachute Riggers. However, first class and chief Parachute Riggers are responsible for the proper fitting and adjusting the mask to the individual wearer.

The A-13A pressure breathing mask is supplied in 3 sizes; small, medium, and large. The correct size will hug the face comfortably, and the inside flap will fit tightly around the nose and mouth area. The A-13A oxygen mask, adjusted to the helmet liner, is shown in figure 6-37. This oxygen mask is classified as personal equipment.

Oxygen masks are issued through regular supply channels under the supervision of the Supply Officer, through the Flight Clothing Issue Section of the Supply Department. After drawing new flight gear, a pilot will take this equipment to the parachute loft for assembly and fitting, especially when items like the hardshelled helmet, liner, microphone, and mask are included in his list. The headphones used in the helmet liner are installed by electronic personnel.

When the pilot or airman has selected the size mask best suited to his face, the Parachute Rigger will have little or no difficulty in aiding him to adjust the mask properly; that is, obtaining a secure and comfortable fit. Occasionally, however, every detail of the fitting process is not successful. The individual

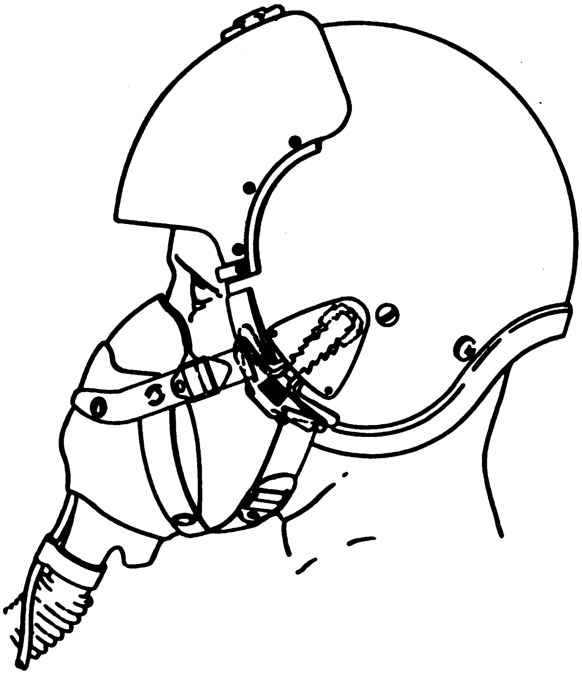


Figure 6-37.—A-13A oxygen mask adjusted to helmet, using Hardman Retention kit.

concerned in the problem may have sharp features or the bridge of his nose and the indentation between the chin and lips may be so confined that none of the 3 mask sizes available can be adjusted to a leakproof fit. The problem of successfully fitting the non-conforming features of an individual is not entirely hopeless. The inner lip of the mask can be built up using a thin layer of specially developed soft sponge rubber laminate cemented into place. Ordinary sponge rubber cannot be used. This special sponge rubber laminate seal contains thousands of tiny air sacs which will expand at altitude, thereby assuring a more leaktight fit.

APPLICATION OF THE LAMINATE SEAL.—For application of the laminate seal, the following instructions will apply:

1. Roughen the sealing surface of the inner lip of the mask with emery paper.
2. Apply an even, medium weight coat of approved cement to the rough side of the laminate seal and to the surface of the mask just roughened.
3. Line up and determine the top and bottom centerlines of the inner lip and the laminate in preparation for adhering the pieces together.
4. When the cement is tacky, gently la the upper nose section of the laminate se in place, lining up with the centerlines concerned. While doing this, take care not t make contact with the lower portion until th proper overall alignment has been assured.
5. After aligning the laminate seal with th inner lip surface of the mask, lay it in place pressing tightly together. Allow the contactin surfaces to dry at least an hour. If the laminat seal is wrinkled or not positioned correctly strip it from the facepiece, cleaning the surfac with solvent (ethyl acetate) before installing new seal.
6. Masks fitted with this laminated se require added care in handling especially whe they are cleaned periodically with a soft soa solution to remove particles of dirt and drie perspiration.

To install a new metal yoke harness assembly the mask tube must be removed and the yok slipped on over the breathing tube extensio of the mask. After this, the tube is secured back in place. The metal yoke and harness combination was designed to replace the old style harness which was suspended higher on the mask through the use of molded rubber lugs. By suspending the mask from a lower position and adding the laminate seal to the inner lip of the facepiece, a better and more comfortable fit for a greater number of individuals was made possible.

New production masks are being fitted with the laminate seals and metal yoke assemblies. Masks which have been modified in the field will eventually be replaced by the production models (either the entire mask assembly or just the facepiece in accordance with conditions) as soon as they are made available.

The replaced masks are not turned in t supply, but are retained by squadrons or stations as spares, and modified when yokes and seals become available. All necessary repairing an component replacement of old or new mas assemblies and components will be performe by the organization using the equipment or othe authorized activities, in accordance with loca instructions.

FITTING THE A-13A OXYGEN MASK.—The rmal adjustment steps involved in fitting the -13A pressure breathing oxygen mask are as llows:

1. Place the mask over the Pilot's nose d mouth. While holding the mask in position, heck its fit by stopping off the bailout connector let. Have the pilot try inhaling gently to see the mask will cling to the contours of the ce, making further inhalation impossible. his is merely a preliminary check to see that e size selected is suitable. If the size elected is not suitable, inhalation will most ikely be made possible by a poor seal around e bridge of the nose. When the preliminary itting proves successful, go on to the next tep.

2. Have the pilot place the under-helmet iner on the head, adjusting and tightening the hinstrap. Attach the mask harness to the liner nd adjust to a comfortable but secure fit. he mask cheek flaps should be under the liner gainst the face. Cheek flaps may be trimmed f the mask proves to be uncomfortable under he liner. In some cases it might be advisable o completely trim off the cheek flaps up to the nner lip portion. Make a second preliminary heck for mask leakage as described in step 1.

3. With both inhalation valves and the compensated exhalation valve installed in the mask ssembly, place a clean smooth rubber stopper irmly in the oxygen inlet end of the end connector ssembly, attached to the end of the mask ose, and perform the following tests:

To test the inhalation valves, hold the mask lose to the pilot's face, but not sealed to he face. While supporting the connector (at he end of the mask hose) steadily in the and, have him inhale deeply. After inhaling, ress the mask to the face, and have him xhale forcibly and completely through the xhalation valve. If the inhalation valves are ot closing properly, the exhalation valve will ot open. If the inhalation valves are seated roperly, the exhalation action will be smooth vith a minimum of resistance noted.

To test the exhalation valve, place an obstrucion (rubber band or equivalent) under the ubber flapper of one of the inhalation valves n a manner to prevent the flapper from forming seal. Repeat the testing procedure described or testing the inhalation valves. If the exhalaion valve is functioning properly, it will not open when the subject inhales, and exhalation through the valve will not be possible.

To test for mask hose and fitting leakage, remove the stopper, affix the mask assembly to the face with the helmet in place and, using the mask suspension harness, adjust the straps for a snug comfortable leaktight fit. Again, block off the inlet port of the mask hose connector assembly, and have the pilot inhale sharply and deeply, holding or attempting the inhalation action as long as possible. If there is no inboard leakage, immediate signs of suffocation will be evident.

4. As a preflight inspection to leak test the mask in the aircraft which have oxygen flow indicators, check the mask in the following manner:

Adjust the mask securely in place and connect it to the regulator breathing extension tube or console. With the oxygen system turned on, place the regulator safety pressure selector lever in the ON position. Induce a severe outboard mask leakage by placing two fingers under the mask sealing surface and observe the flow indicator which should remain in the FLOW position. If there is no mask leakage, the flow indicator will remain in the NO FLOW position. Leakage will cause the flow indicator to assume an actuated position. Adjust the suspension straps until the leakage is stopped, if possible. Return the safety pressure selector lever to the OFF position.

DO NOT USE A MASK THAT LEAKS. This is the final groundleak test that can be given a mask when a decompression chamber and medical examiners are not available. A mockup oxygen system, installed in the shop or loft, can be used to make a final groundleak check. If this cannot be done due to a critical supply condition, the test must be carried out on an aircraft system.

Instruct all pilots to check the mask fit during flight by actuating the safety pressure, and taking a deep breath and holding it. Note position of the oxygen flow indicator. If the flow indicator opens, excessive leakage is indicated. Tighten the mask straps until the flow indicator closes.

A-14 Oxygen Mask

The A-14 oxygen mask should be used with a demand type system not having safety pressure features. It is designed to supply adequate oxygen at altitudes up to 37,500 feet. With precaution, adequate oxygen is supplied for short durations at 40,000 feet.

The A-14 mask assembly consists of a mask body which completely covers the nose and mouth. It is fitted with an exhalation valve of the rubber flutter type. The adjustable straps of the suspension harness shown in figure 6-38 are arranged differently in comparison with the pressure type mask. Since this mask was not designed to hold pressure, there are no inhalation valves installed in the open ports. The exhalation valve is very simple in construction and is designed to prevent air from entering the mask upon inhalation.

There are no inner lips in the A-14 mask. The exhalation valve, seated in the bottom of the mask, permits exhaled air to flow out of the mask through two ports, one on each side of the mask exterior. The A-14 oxygen mask may be replaced with the A-13A pressure breathing mask on any demand type regulator; however, substitution of the A-14 mask in place of the A-13A is not permissible.

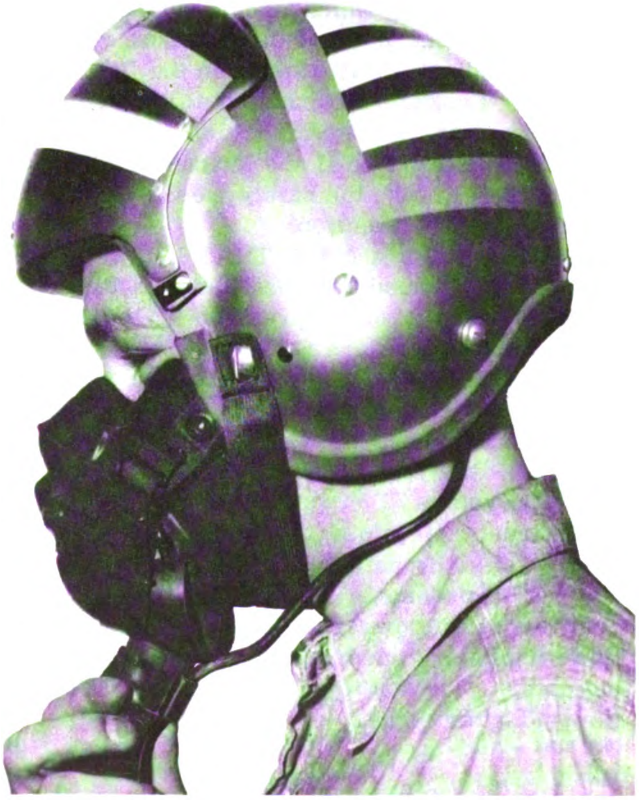


Figure 6-38.—A-14 oxygen mask (left-side view) showing position of the straps.

FITTING THE A-14 OXYGEN MASK.—The normal fitting procedure for the A-14 oxygen mask follows:

1. Select the size mask (small, medium, large, or extra large) which corresponds to the facial characteristics of the individual to be fitted.

2. To effect a proper and comfortable integration of oxygen mask and helmet, the assistance of a Parachute Rigger is needed. Have the individual put on his helmet. Have the wearer hold the mask so that it fits snugly to the face. Hold adjustable straps on the left side of the mask up to the helmet so that the snap fasteners are in the most suitable position. Mark clearly the location for the helmet studs by inserting a pencil point through the center hole of the sockets. To position the helmet studs on the right side, engage the buckle loop of the mask suspension strap with the helmet sidehook and follow the above procedure for determining and marking the positions of the right side helmet studs.

3. When the helmet stud positions have been marked, remove the helmet and mask and attach studs as follows: For summer helmets, three helmet webbing straps, with studs attached are provided. These straps with two studs each are sewed to the left side of the helmet in accordance with the markings. The four-stud piece of webbing is sewed on the right side. The webbing straps are necessary for reinforcement of the studs. The four-stud arrangement makes it possible to shift the position of the right side adjustment strap containing the loop.

4. The studs may be individually positioned on summer type helmets as well as winter type helmets, but reinforcement is necessary to prevent tearing of the lightweight helmet. Therefore, apply the stud so that a reinforcing tape will completely infold the base of the stud with the face end of the material fastened beneath it. In addition to acting as a reinforcement the tape also prevents contact of the face with the metal stud base. Thus the possibility of frostbite during flights below zero is eliminated.

5. For winter type helmets, or for any helmet to which the webbing straps cannot be

conveniently sewed, individual stud and eyelets will have to be attached. Using a revolving belt punch, make the number of necessary holes at the located points through the helmet, and set the fasteners. To prevent metal contact with the face, a piece of fabric cut to size may be cemented directly over each eyelet base.

6. Snap the helmet sidehook securely to the right side helmet studs. Have the wearer don the helmet and attach the mask. Tighten the suspension straps until the mask is snug and comfortable with equal tension all around. Cut off the excess length, if any, of suspension straps and secure the loose ends with metal clinches.

7. Test the mask for leakage by placing the thumb over the disconnect at the end of the mask tube and have the pilot inhale gently. If there is no apparent leakage, the mask will adhere to the face and further inhalation will be impossible.

APH-5 Protective Helmet

The APH-5 protective helmet (fig. 6-39) is furnished in two sizes, medium and large. The complete unit consists of an outer shell, energy-attenuating liner, sizing pads (sets of three thick and three thin), an integrated visor, earcup assemblies (containing the earphones), communication cord, oxygen mask mounting tabs, and adjustable chinstrap. In addition, an envelope containing four shims and two 1/2-inch screws for horizontal adjustment of the earcup assemblies, and a sizing instrument to be utilized in fitting the helmet properly are issued with each helmet.

The outer shell provides force-distribution and penetration-resisting properties. It is molded from glass fabric and a polyester resin. The liners are provided to absorb or dissipate impact energy and thereby prevent skull fracture and/or brain injury. There are three sections (molded from cellular polystyrene sheet) cemented to the inside of the shell to fit the contour of the inside shell.

The sizing pads permit fitting of the helmet to an individual's head contour with the proper balance between stability and comfort. They are supplied in three basic configurations—back, crown, and front, also in two basic thicknessess—thin and thick. *Aviation Clothing and Survival Equipment Bulletin* No. 3-57A, authorizing modification of the sizing pads, must be complied with on all helmets still in service.

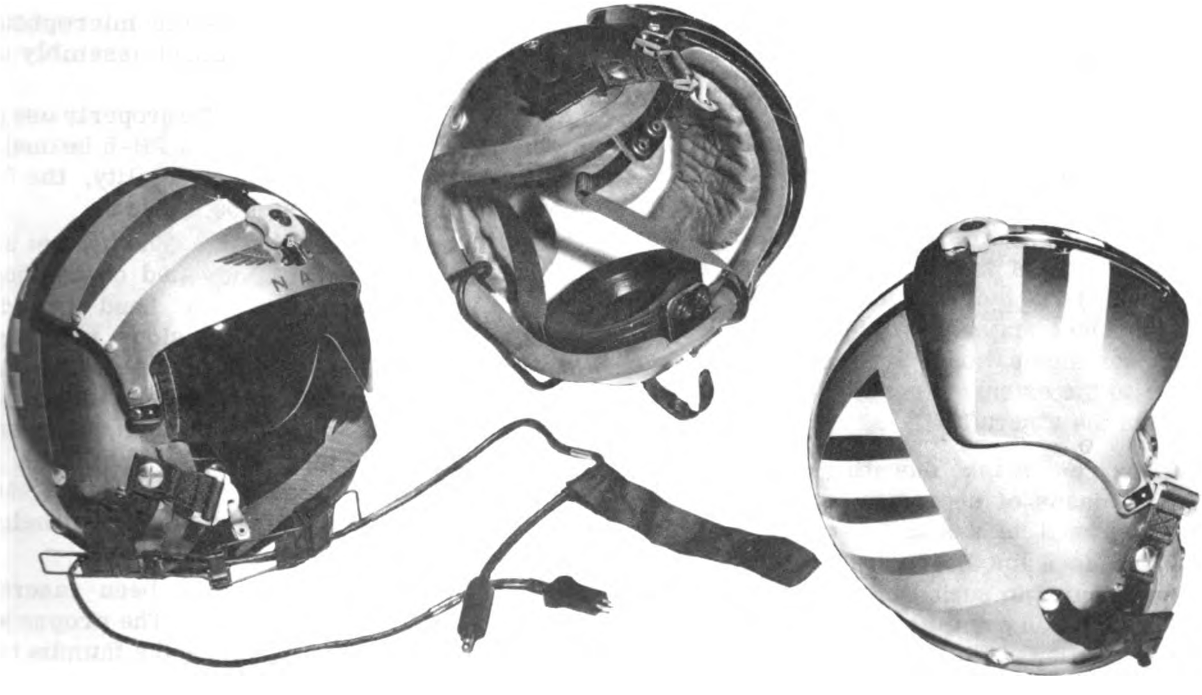


Figure 6-39.—APH-5 protective helmet.

The integrated visor provides protection from sunglare, wind blast, dust, foreign particles, and flash fires. It has excellent optical properties and is protected from damage when in the UP position by a housing molded from a glass fabric and polyester resin. Two colors of visors are available for use in the helmet assembly, clear and neutral gray. The neutral gray visor, which is darker at the top than at the bottom to afford maximum protection from sunglare and facilitate reading of the instrument panel, is currently supplied in three shades.

The earcup assemblies contain the earphones and improve radio reception by providing good attenuation of outside noise. Each assembly consists of a phone housing of cellular polystyrene and an ear cushion assembly composed of a soft neoprene foam rubber body and a di-isocyonate foam face cushion. If the earcup assemblies are loose and need adjustment, the four shims and two screws contained in the envelope should be utilized to accomplish the lateral adjustment. Proper fit of the earcup for good external sound attenuation which will permit a high signal to noise ratio is necessary for proper radio reception. The type H-87A/U or H-87B/U earphones are installed in the cellular polystyrene earcup of the ear cushion assembly. Each earphone is connected to the two wires leading out of each side of the molded junction block of the communication cord.

The communication cord is designed to provide electrical connections between the earphones and the aircraft radio facilities. The molded junction block connecting the four earphones leads to the cord is located in the back left center of the helmet. The communication cord jack incorporates a transformer for impedance matching of the headphones to the communications system output and connects to the extension cord leading from the jack box in the aircraft.

The oxygen mask mounting tabs are to provide a means of securing the oxygen mask to the face and to assist in achieving a seal around the face in the oral-nasal area. The tabs are mounted in such a manner and position so as to permit an even distribution of pressure over the sealing area of the mask. Another function of the tabs is to assist in retaining the helmet and mask during bailout at high speeds. The chinstrap is also designed to retain the helmet during exposure to windblast at speeds in excess of 500 miles per hour. *Aviation Clothing and Survival Equipment Bulletin* No. 24-58 covers the installation of the nape strap and must be complied with on all helmets not equipped with nape straps.

Hardman oxygen mask retention kits are provided for installation with the APH-5 helmet to improve retention of the helmet and mask during ejection. *Aviation Clothing and Survival Equipment Bulletin* No. 17-58A covers the installation instructions for these kits. The chinstrap is to be used in addition to the Hardman suspension for maximum retention of the helmet. A boom mike may be installed on the helmet if an oxygen mask is not used.

The Hardman oxygen mask retention kit is shown in figure 6-40; the kit fitted to the A-13A oxygen mask is illustrated in figure 6-40.

BOOM-TYPE MICROPHONE ATTACHMENT.—The installation of a boom-type microphone should be accomplished as follows:

Pre-position the boom mike assembly on the side of the helmet. Swing the boom through a full arc to determine the optimum point. Then, scribe the intended position of the bracket, drill holes accordingly, and attach. The position will vary with the face shape and personal preference. Boom-type microphones are not provided with the helmet assembly and must be ordered individually.

FITTING TECHNIQUES.—To properly use the sizing instrument and fit the APH-5 helmet to obtain optimum comfort and stability, the following instructions should be applied:

1. Determine head length. The helmet size and liner thickness are indicated on the horizontal bar. Determine the head breadth. When the head length dimensions provide a choice between two sizes of helmets, the head breadth should be a factor in determining the proper size. If the head breadth is over 6 inches, use the large size helmet with all thick liners (sizing pads). If the head breadth is under 6 inches, use the medium size helmet with all thin liners.

2. After the liners have been inserted, have the pilot don the helmet. The proper way to don the helmet is to place the thumbs over the ear cushions, and pull outward on the helmet; insert the forehead in the area between the thumbs and complete the donning by rolling

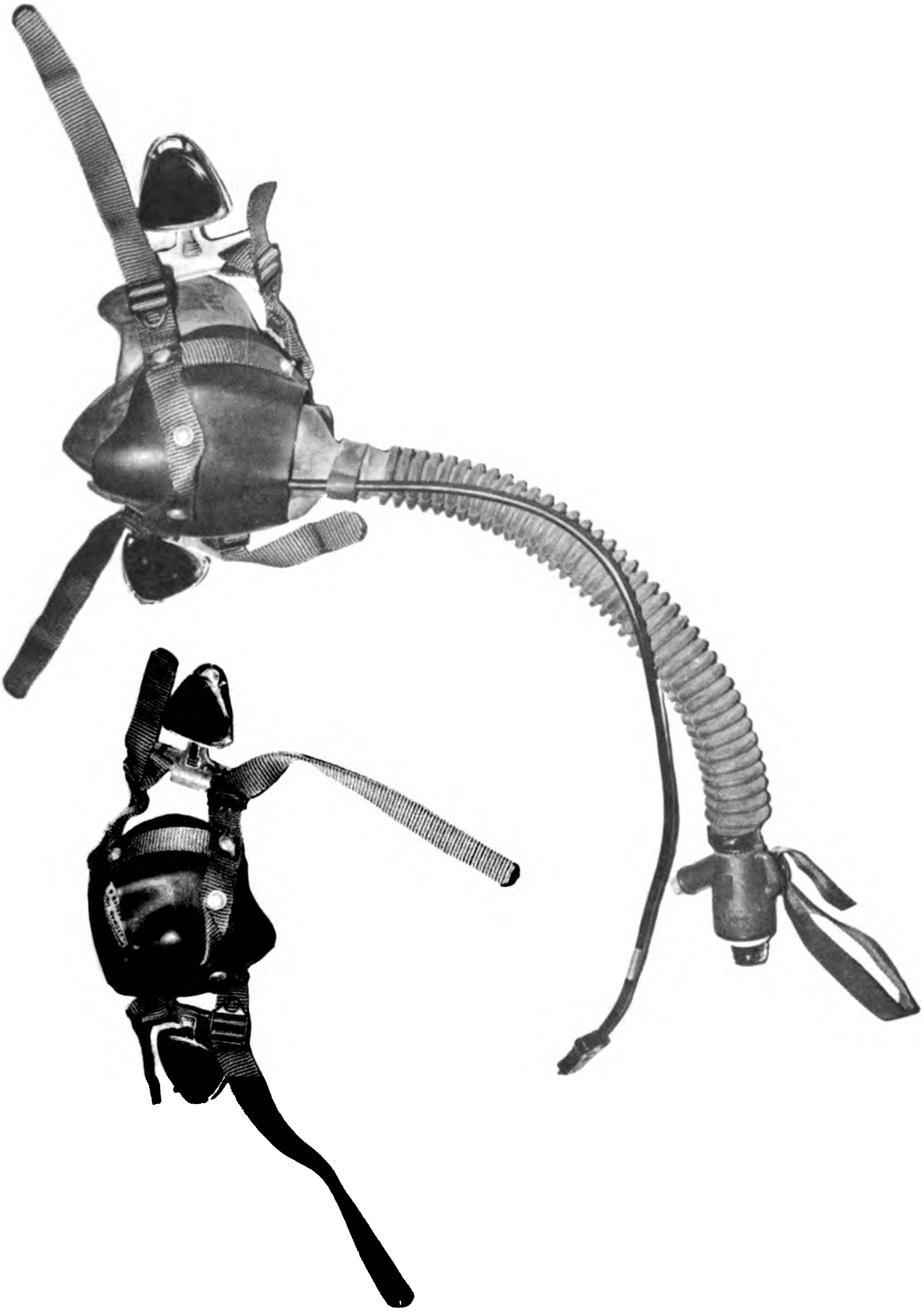


Figure 6-40.—Hardman oxygen mask retention kit; retention kit attached to A-13A oxygen mask.

the helmet backward until it is positioned to his satisfaction.

If the pilot is not comfortable or the helmet lacks stability, make the following suggested revisions:

COMFORT.—If a thick liner is used in the area affected, substitute a liner of lesser thickness. If the pressure point remains, choose next larger size and use the thick liners in the unaffected area and thin liners in the affected area.

STABILITY.—To obtain maximum stability, a snug fit is required. It is possible that stability has been sacrificed for comfort in relieving the pressure points. Proper stability can be determined by vigorously shaking the head. Keep in mind that the pilot must be the judge in determining the correct balance between comfort and stability of the helmet.

CLEANING THE VISOR.—The visors are probably the easiest damaged part of the helmet. They must be protected at all times when not in use to prevent scratches. When cleaning is necessary, only nonabrasive soap or detergent and clean water should be used for dirt and mud removal. Grease may be removed with hexane, kerosene or white gasoline only. Never use aromatic fuels on or near the visor since they will cause surface crazing. When cleaning use only the hands or a soft, clean cloth or chamois. The visors must never be rubbed with any abrasive material which would result in surface damage and interfere with visibility. Fogging of the visor is prevented by application of MIL-A-21071 (Aer) (S/N RN 6850-200-2397-0500) antifogging compound. In applying this compound, a soft cotton swab should be used to apply a thin film; let dry for five minutes, then remove excess by wiping lightly with a soft, clean cloth. Instructions for replacement of visors are contained in the overhaul manual.

CHAPTER 7

OXYGEN AND OXYGEN TRANSFER EQUIPMENT

The job of procuring, storing, transferring, and testing aviator's breathing oxygen and maintaining oxygen equipment belongs to many persons, and all must work together to provide pilots and aircrewmen with maximum safety at all altitudes of flight. Parachute Riggers have an important part in the performance of these duties and responsibilities.

According to the latest revision to the "Quals" Manual, PR's must be able to operate and maintain liquid and gaseous oxygen shop transfer equipment; shot test and repair regulators and converters; test oxygen for contamination; and maintain regulator and converter shop test equipment.

Although the PR's actual duties and responsibilities will vary with different stations and ships, depending on facilities available, procurement conditions, types and number of aircraft to be serviced, etc., senior PR's should be prepared to perform all the above mentioned duties.

IMPORTANCE OF OXYGEN

Men differ in their reactions to hunger, thirst, and other sensations. Even an individual's reactions vary from time to time and under different circumstances. Illness, pain, fear, excessive heat or cold, and many other factors help to determine what the response will be in each particular case. The same thing is true of individual reactions to oxygen starvation. The effects of a certain degree of lack of oxygen on a given person cannot be accurately predicted. Furthermore, a person may be relatively resistant on one day but highly susceptible the next. The purpose of this section is to acquaint the Parachute Rigger with some of the physical aspects of the atmosphere in relation to the human body. When one understands the importance of oxygen, he will be better able to prepare himself for performing the duties of the Parachute Rigger.

Composition of the Atmosphere

The atmosphere is a mixture of several different gases. A sample of dry air contains about 78 percent (by volume) nitrogen, 21 percent oxygen and about 1 percent argon. In addition, it contains about 0.03 percent carbon dioxide and minute amounts of other gases. The air also contains a variable amount of water vapor. The maximum amount of water vapor that the air can hold depends on the temperature of the air; that is, the higher the temperature, the more water vapor it can hold, up to a maximum of about 4 percent by volume.

The atmosphere is divided into concentric layers. Closest to the earth is the layer known as the troposphere. Next are the stratosphere, ionosphere, and exosphere. The troposphere varies in thickness from the Equator to the poles; its vertical extent is greatest over the Equator (60,000 feet above sea level) and least over the poles (30,000 feet above sea level). This variation is due to the fact that the greater temperature in the region of the Equator causes the air to be less dense and requires a greater volume, or tropospheric height, than at the poles where the cold air is very dense. The boundary between the troposphere and the stratosphere is referred to as the tropopause. (See fig. 7-1.)

TEMPERATURE.—The variation of temperature in the atmosphere is as follows:

1. From the ground up to about 35,000 feet, the temperature normally drops at the rate of approximately 3 1/2° F. per 1,000 feet of altitude. By 10,000 feet, the temperature has dropped 35° F. below ground temperature; at 20,000 feet it has dropped to 70° F. below ground temperature; and by 35,000 feet the temperature is 126° F. below that existing on the ground. Normally, we speak of a standard ground temperature, 59° F., which is the representative average temperature on the surface of the earth at U. S. latitudes. Consequently, the temperature at 35,000 feet is generally taken as being

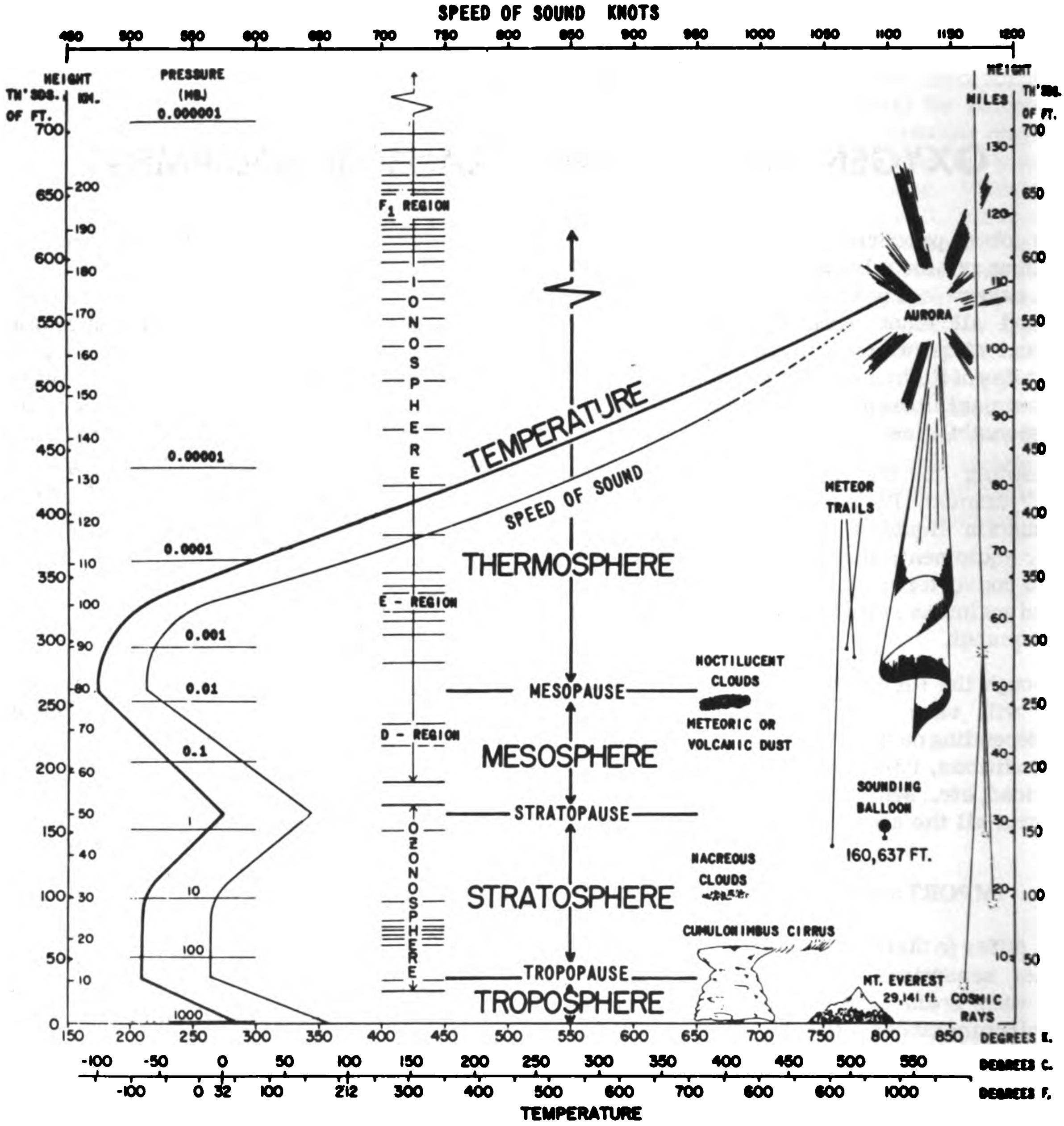


Figure 7-1.—Divisions of the atmosphere.

126° F. below the standard ground temperature, or -67° F.

2. From 35,000 to 150,000 feet, the air stays at about -67° F.

3. From 80,000 feet up to 190,000 feet the temperature slowly rises to a maximum of 49.10° F., then drops to a -2.73° F. at 200,000 feet and continues to drop to a maximum of -105.34° F. at 300,000 feet. At 400,000 feet the temperature is 276° F. and continues to rise to 2,238° F. at 1,800,000 feet.

DISCOVERY OF OXYGEN.—The history of the discovery of oxygen, less than two centuries ago, is interesting. Joseph Priestly, an English clergyman who came to the United States to live, experimented a great deal with gases. On August 1, 1774, when heating a glass tube of mercuric oxide, a red powder, he noticed a ilvery mirror forming on the cold portions of he tube. This he recognized as mercury. But colorless gas was also escaping. What might he gas be? A lighted candle, when plunged into he gas, burst in a glaring flame. A mouse, when ut into a glass jar with the new gas seemed to ecome more frisky. Priestly felt braced when e inhaled the gas. Priestly thus is given the redit for discovering oxygen; although a Swedish hemist, Karl Scheele, actually had found it two ears before him. Priestly, however, did not now about it and he was the first who made the iscovery public.

Atmospheric Pressure

Although extremely light, air has weight and highly elastic and compressible. Because of s weight and density, the atmosphere exerts a rtain pressure. The amount of pressure it erts upon the surface of the earth at sea level 14.7 pounds per square inch (p.s.i.). Its olecules press in all directions at the same time; and this makes it possible to measure its pressure by several different means.

As one ascends higher into the atmosphere, it becomes less dense and colder. (Study fig. 7-2.)

MEASURING ATMOSPHERIC PRESSURE.—Measurement of atmospheric pressure is accomplished by use of a barometer. This is a sensitive instrument responding to the pressure exerted by the molecules contained in the air. In its simplest form a cup or cistern barometer consists of a graduated glass tube filled with mercury and inverted in a cup containing mercury. The height of the column of mercury in the tube varies in response to changes in atmospheric pressure.

An aircraft altimeter is, in a sense, a barometer calibrated in feet instead of inches, operating on the same principles of measurement, but using an aneroid (vacuum sealed metallic bellows) instead of mercury in a glass tube, A pointer connected through linkage with the aneroid of an aircraft altimeter registers the

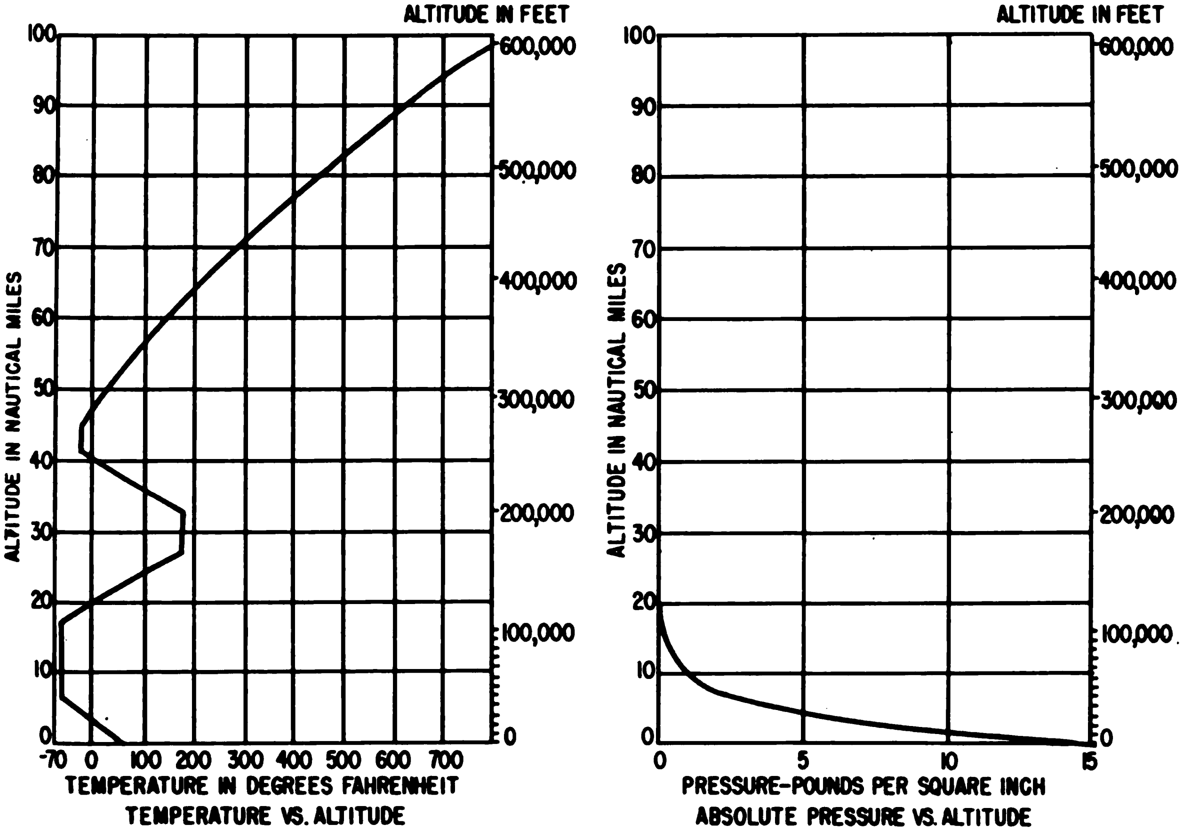


Figure 7-2.—Atmospheric pressures and temperatures at various altitudes.

altitude on the face of a dial. Observance of the altitude is mandatory to the well-being of all those who fly in aircraft.

PARTIAL PRESSURE OF OXYGEN.—The decrease in pressure with altitude has effects of the greatest importance upon one's ability to function as a pilot or crewman. Since oxygen composes only 21 percent of the atmosphere by volume, it is considered as having a partial pressure value of approximately 3 p.s.i. at sea level. This partial pressure is often referred to as being necessary to the sustenance of life which incidentally is true when we consider the density and weight factors involved in all types of gases.

Anything that has mass has weight; and like liquids, certain kinds of gases will flow or be absorbed more readily than others. In direct relation to the last statement it can be said that it takes a required amount of pressure to force a liquid or gas through a restricting member like a filter or a membrane. Three pounds of partial oxygen pressure is sufficient to force oxygen into the bloodstream.

At 18,000 feet the atmospheric pressure registers a mere 7.35 p.s.i. as compared to 14.7 p.s.i. on the ground. Remembering that oxygen comprises 21 percent by volume of the atmosphere, we can easily see that the oxygen pressure of 3 p.s.i. is reduced to approximately 1.50 p.s.i. or half the pressure required in the lungs to supply the blood with oxygen. Therefore, it is apparent that, as we gain in altitude, we must provide ourselves with some artificial means to retain the vital 3 p.s.i. of oxygen pressure.

OXYGEN PHYSIOLOGY

Physiology deals with the processes, activities, and phenomena of life and living organisms. It is the study of the functions of the organs and parts during life, as distinct from anatomy. Oxygen physiology deals with the same subjects, but more directly with the effects of oxygen, or the lack of it, on the human body.

The purpose of breathing is to get oxygen into the bloodstream and carbon dioxide out. This exchange is made through the walls of millions of tiny sacs and blood vessels in the lungs. The importance of this function may be judged from the total surface of these sacs, estimated to be between 700 and 800 square feet, or 40 to 50 times the skin surface of the body. The walls of the sacs are thin, moist, and porous, thus enabling oxygen to be pushed through this barrier. Oxygen is also pushed through small tubes in the walls of the tiny blood vessels surrounding each sac. These tiny tubes connect with a large artery which carries blood from the heart to the lungs and with veins which carry the blood back to the heart. The heart pumps blood throughout the body where oxygen burns the food, making the heat needed to keep the human machine going.

The blood carries oxygen in the red blood cells or solid substance of the blood. These cells carry oxygen at about 95 percent of their total capacity, which is about a pint of oxygen in every five pints of blood. The red cells pick up oxygen easily at ground-level atmospheric pressure, such as is found in the lung sacs, and release it quickly at lower pressures, such as are found in the body's tissues. As oxygen is released, the waste carbon dioxide is picked up and returned to the lungs, where it is exhaled into the air. Figure 7-3 illustrates how oxygen is admitted and distributed throughout the human body, and how carbon dioxide (CO_2) is expelled.

Oxygen in Relation to Altitudes and Breathing

USE OF OXYGEN IN HIGH ALTITUDE FLYING.—In the combat operations of the Air Force during World War II, more than 200 fliers died from the lack of oxygen. An estimated 11,000 more became unconscious for the same reason, but were revived by crewmembers who restored their oxygen supply and, on some occasions, applied artificial respiration.

Remember that the higher the altitude, the less the pressure. The less the pressure, the less oxygen in the blood. The less oxygen in the blood, the effect on the body becomes worse. The longer all this continues, the more the effects of oxygen deficiency increase.

EFFECTS OF THE LACK OF OXYGEN.—The result of a decrease in partial pressure of oxygen in the air results in an insufficient amount of oxygen entering the bloodstream. The body reacts to this condition rapidly. As ascent into the atmosphere increases, the partial pressure of the oxygen—the driving force tending to push it into the bloodstream—decreases still more, and the lack of oxygen is felt even more rapidly. This deficit in oxygen is called hypoxia.

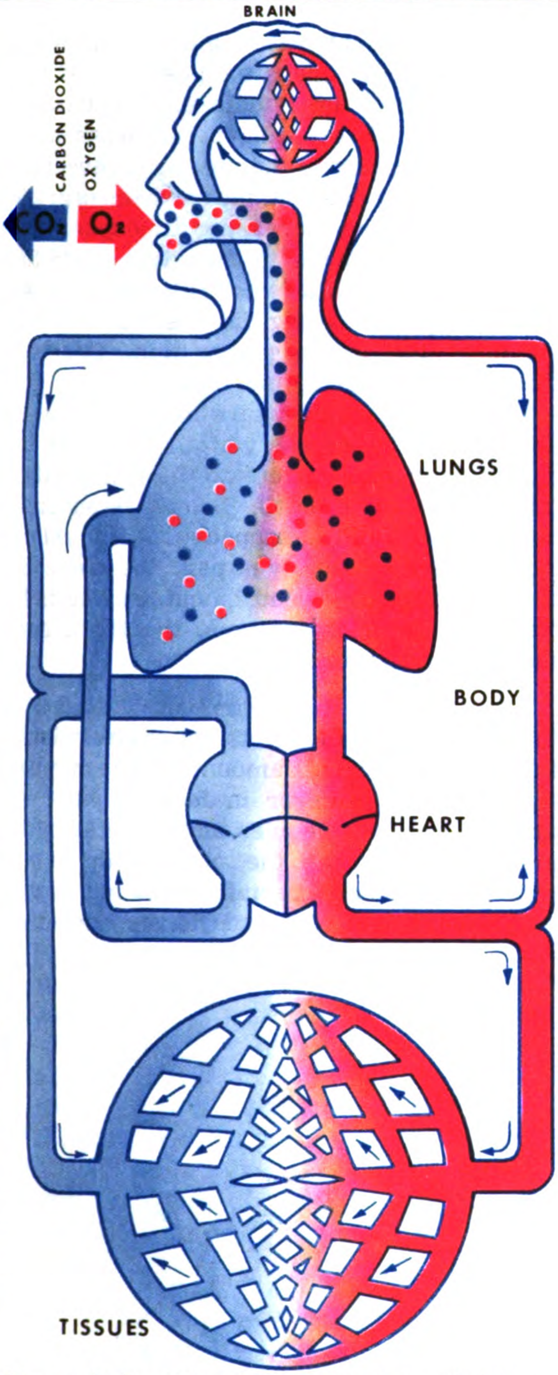


Figure 7-3.—Circulatory system of the human body.

complete lack of oxygen, which causes death, called anoxia. If the body is returned to its ormal oxygen supply, one may recover from ypoxia, but cannot recover from anoxia.

One of the strangest things about hypoxia is e way it creeps up on a person. Without water or food one gets hungry or thirsty—these are the warning signals sent out by the body to indicate it is time to refuel. When the oxygen supply is being cut down, little or no warning is received. It is one case where nature did not provide an adequate warning system.

One of the earliest and most striking effects of hypoxia is a loss of vision—not a total loss, but a decrease in ability to see clearly. The loss of vision is due to the fact that the brain is affected by a lack of oxygen before other parts of the body. The eyes which are usually thought of as part of the brain are, therefore, among the first of your senses to show the effects of the lack of oxygen.

When the brain is deprived of oxygen, the ability to concentrate and memory of recent events are lost. Since the brain is the first organ affected, everything else fails.

Perhaps you have thought that one way to obtain more oxygen would be to breathe faster. This is true as more oxygen is absorbed into the bloodstream, but it will cause unconsciousness if rapid breathing is continued too long.

By breathing more rapidly, the carbon dioxide in the bloodstream, which controls the rate of breathing, is eliminated more rapidly. It is not the fact that the body needs more oxygen that causes breathing to become deeper or more rapid, but it is due to the effect of carbon dioxide which must be expelled from the lungs. If too much carbon dioxide is eliminated, strange sensations will be experienced. Dizziness will occur and spots will appear in front of the eyes. The fingers and toes will get numb and eventually may even become paralyzed.

EFFECTS OF CHANGING PRESSURE.—As an aircraft ascends and descends, the resulting changes of pressure may affect aviators in several ways. For example, gases in the intestine normally will escape when the pressure becomes excessive, but if the escape is prevented the aviator may experience considerable pain. If the air should become trapped in an aviator's sinus during flight, aches and pains in the forehead, cheekbone, upper teeth, or around the eyes may result. Note figure 7-4, showing "dysbarism" caused by trapped air.

A sinus might be compared to a blind alley. It is a passageway leading from the airway of the nose into a bone of the head. The width of the opening into the sinus varies from person to person. The opening sometimes is obstructed by mucus or by a swelling of the nasal membrane. It then becomes a closed bottleneck, trapping air at the sinus. If such blockage occurs as the aircraft climbs, pressure increases within the sinus; if blockage occurs during descent, pressure is greater outside the sinus. Either condition may cause severe pain. Sometimes blowing the nose or clearing the throat will remove the obstruction and relieve the pain. The use of nose drops which shrink the nasal membranes helps to keep the passage clear, but too frequent use of such medications may produce irritation and congestion, an effect just opposite to that desired. Persistent trouble with sinuses should be reported to the flight surgeon.

Aviators often complain of ear trouble, especially when they have to fly with a sore throat or cold in the head. Again, trapped air is responsible for the discomfort. In this case, the trapped air is just behind the eardrum in a pocket or cavity, as can be seen in figure 7-5. This cavity opens to the outside air through the Eustachian tube, a narrow tube leading to the throat.

Normally, as the aircraft climbs, air automatically escapes into the throat, equalizing the pressure on the inner and outer surfaces of the eardrum.

During descent, yawning or swallowing at intervals normally opens the passage and permits air to reenter the middle ear, equalizing the pressure and preventing pain. When a swelling or obstruction in the passage prevents a flow of air during a descent, the eardrum is gradually pushed in by the increasing atmospheric pressure. At first there is merely a stuffy feeling in the ear but if this is not relieved by yawning, swallowing, or blowing the nose, the stuffy feeling may give way to severe pain. Descent will then have to be made more slowly.

If the reduced pressure in the middle ear is not relieved by the entry of air from the throat, bloody fluid may ooze into the ear cavity from the surrounding tissues. It may be several days before this fluid disappears. Meanwhile, although there is usually no pain, the ears continue to feel stuffy or "dead", and hearing is below normal. In such matters, the flight surgeon should be consulted.

Teeth may also develop pain in flight. While the exact cause of this is not entirely known, it is thought that small amounts of gas may become trapped in cavities or in decayed pulp. As the aircraft climbs, the pressure exerted by the gas presumably causes the pain. Pain in a tooth which has recently been filled is not an uncommon experience. Unless it is very severe, such

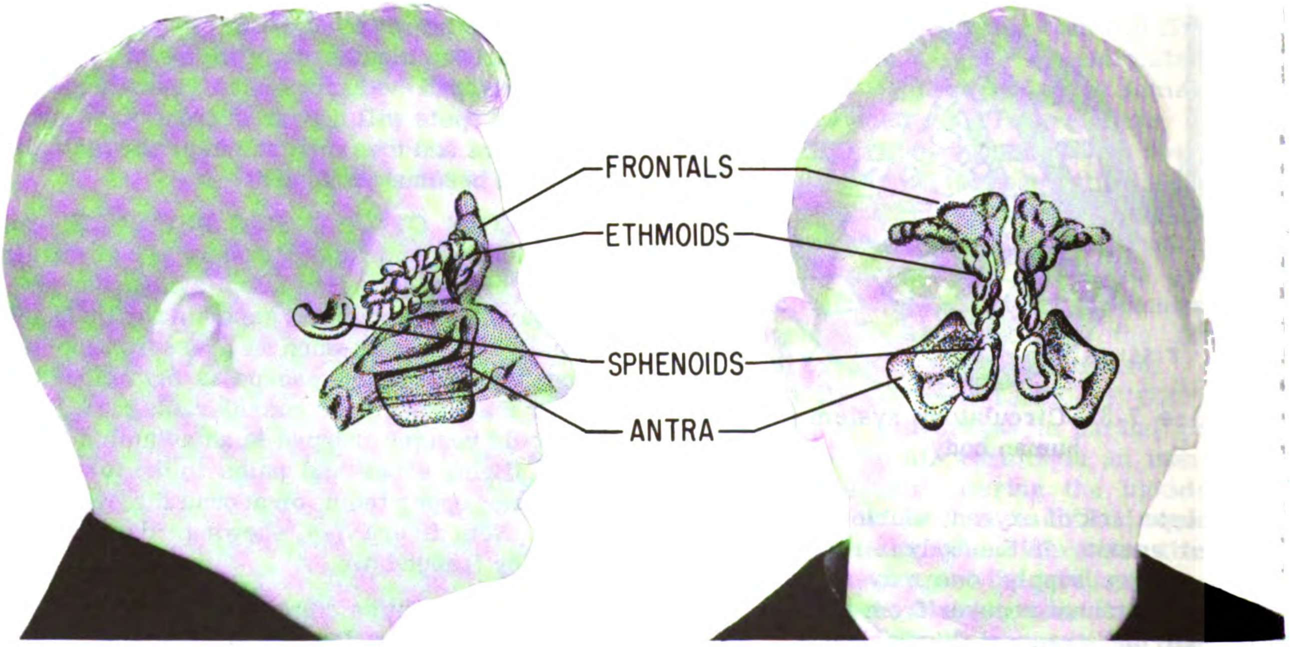


Figure 7-4.—Trapped air may cause aches within the sinuses.

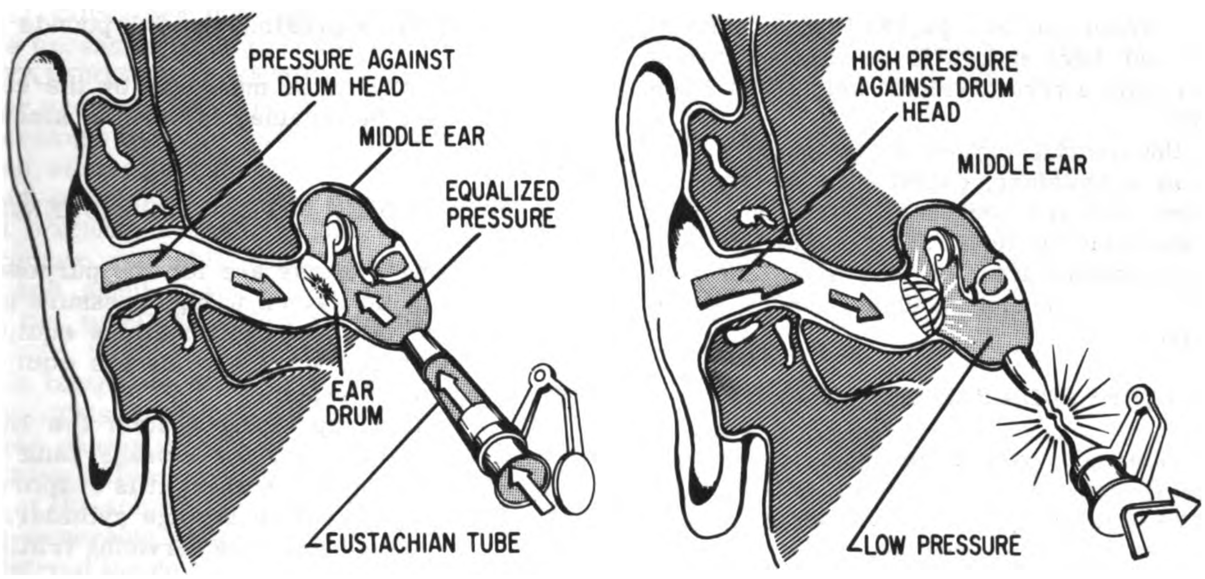


Figure 7-5.—Pain in the ears.

ain need not cause any anxiety. Any severe ain in a tooth should be reported to the dental fficer.

CHARACTERISTICS OF OXYGEN

Oxygen, in its natural state, is a colorless, dorless, and tasteless gas. Oxygen is con- idered to be the most important of all the lements. As mentioned earlier, it forms about 1 percent of the atmosphere by volume and 3 percent by weight.

Of all the elements in the universe, oxygen s the most plentiful. It makes up nearly one- alf of the earth's crust and approximately one- fth of the air we breathe.

Oxygen combines with most of the other ele- ents. The combining of an element with oxygen s called oxidation. Combustion is simply rapid xidation. In almost all oxidations, heat is iven off. In combustion the heat is given off o rapidly it does not have time to be carried way; the temperature rises extremely high, nd a flame appears.

Some examples of slow oxidation are the usting of iron, drying of paints, and the chang- g of alcohol into vinegar. Even fuels in storage re slowly oxidized, the heat usually being arried away fast enough; however, when the eat cannot easily escape, the temperature may ise dangerously and a fire will break out. This s called spontaneous combustion.

Oxygen does not burn, but does support combustion. In other words, MATERIALS BURN MORE READILY AND MORE VIGOROUSLY IN OXYGEN THAN IN AIR.

In addition to existing as a gas, oxygen can exist as a liquid and, below -361° F. as a solid. Liquid oxygen is pale blue in color. It flows like water, and weighs 9.54 pounds per gallon.

Liquid oxygen, commonly referred to as Lq. Ox., is obtained by a combined freezing and pressurization process. When the temperature of gaseous oxygen is lowered to -182° F. under about 2,000 p.s.i. pressure, it will begin to form into a liquid. When the temperature is lowered to -297° F., it will remain a liquid under normal atmospheric pressure.

Once converted into a liquid, oxygen will remain in its liquid state as long as the temperature is maintained at or below -297° F. The liquid has an expansion ratio of 862 to 1, which means that 1 volume of liquid oxygen will expand 862 times when converted to a gas at atmospheric pressure. Thus, 1 liter of liquid oxygen will produce 862 liters of gaseous oxygen.

Until a few years ago, oxygen for crewmembers was carried in naval aircraft in the gaseous state. As flight durations increased, however, it was found that the weight and space problem entailed in carrying sufficient gaseous oxygen in either high- or low-pressure containers was increasing. Liquid oxygen has proven the answer to this problem. In its liquid state, oxygen can be "packed" into containers small and light enough to be carried even in fighter type aircraft without weight and space penalty.

In the aircraft, oxygen is carried in its liquid state in a container, called a converter. It is equipped with the necessary valves and tubing for vaporizing the liquid and warming the gas to cockpit temperatures for breathing. The converter is a vacuum insulated double walled container.

TYPES AND GRADES OF OXYGEN

Breathing oxygen is furnished in two types (I and II) and two grades (A and B). Type I is gaseous oxygen; type II is liquid oxygen. Grade A is for aviator's breathing purposes, while grade B is for industrial and medical use.

A water vapor content is specified for grade A but not for grade B. Grade A oxygen contains not more than 0.02 milligrams of water vapor per liter of gas at 70° F. That is practically bone dry, and will suffice as an explanation for the extreme precautions taken to keep oxygen containers free from the water vapor found in the air.

These precautions are not taken to avoid physical injury to the body. We can breathe air containing a high percentage of humidity indefinitely without any serious ill effects. The moisture problem affects the aircraft oxygen system in the small orifices of the regulator. Freezing temperatures can clog the system with ice and prevent oxygen from reaching the pilot or crewman. Extreme precautions must be taken to safeguard against this water vapor hazard.

PROCUREMENT OF OXYGEN

Breathing oxygen is obtained from commercial suppliers for all naval air stations in the continental United States and any overseas activities which have dependable approved sources available. Overseas activities which do not have dependable sources available require a liquid oxygen facility consisting of generation capability in addition to storage and vaporizing capabilities.

Liquid oxygen is stored in large insulated containers on the station. It is measured by the gallon through meter measurement. Liquid oxygen weighs approximately 9.6 pounds per gallon.

Gaseous oxygen is measured by the cubic foot and may be obtained in various sizes of cylinders.

LIQUID OXYGEN VAPORIZING SYSTEMS

Vaporizing systems are for the purpose of converting liquid oxygen to high pressure gaseous oxygen. All naval air stations equipped with liquid oxygen storage tanks are equipped with a vaporizing system.

In a typical vaporizing system the liquid oxygen is drawn from the storage tank and pumped to the vaporizer where it is evaporated and then piped either to storage cylinders or directly to oxygen recharge servicing trailers.

Model FY-1200 Vaporizing System

The Model FY-1200 liquid oxygen vaporizing system is a self-contained unit that only requires an external source of electrical power to the pump motor and the fan motor, and interconnecting piping to a liquid oxygen storage container. The system consists of three main assemblies; namely, the liquid oxygen pump, vaporizer assembly, and charging manifold assembly. The high pressure liquid vaporizing system is an apparatus designed to receive liquid oxygen at approximately atmospheric pressure, compress it, vaporize it, and charge it as a gas into cylinders at approximate atmospheric temperature and at pressures up to 3,000 p.s.i.

A description of the principal components follows.

LIQUID OXYGEN PUMP.—Liquid oxygen enters the pump jacket through a mesh-type suction filter in the low pressure oxygen inlet connection of the pump insulation box. The liquid oxygen pump is of the single cylinder, reciprocating type, and consists of a high pressure, close tolerance mated cylinder and plunger assembly. This assembly is driven through a crankshaft, connecting rod, and crosshead running gear by a 1 1/2 hp. 68 r.p.m. gear motor. The pump is installed in a vaportight insulation box that is filled with high efficiency insulation. The pump compresses the liquid oxygen and discharges it under high pressure to the vaporizer assembly. High and low pressure gages and relief valves are installed to monitor and relieve excessive pump pressures.

VAPORIZER ASSEMBLY.—Liquid oxygen under pressure from the pump is piped to a flow reversing valve panel on the vaporizing assembly which serves to control the direction of flow of liquid oxygen and gaseous oxygen through the heat exchanger coils. The heat exchanger vaporizer assembly consists of a vane axial fan and annular wound heat exchanger coils. The fan supplies ambient air to the coils which transfer the internal energy of the air to the liquid oxygen as it is being forced through the coils. This transfer of energy to the liquid oxygen causes it to vaporize into a gaseous state and have its temperature raised to approximately that of the ambient air. The function of the four flow reversing valves is found in their ability to defrost the coils, allowing continuous operation over long periods. High pressure gaseous oxygen is continuously being delivered to the charging manifold.

CHARGING MANIFOLD.—The high pressure charging manifold is divided into two master shutoff valve controlled sections. Each section is monitored by a high pressure gage. The manifold is designed to charge 6 cylinders at a time on each section. By opening one master shutoff valve, oxygen gas is available at six manifold shutoff valves. Each manifold valve is equipped with a fusible safety plug and a frangible disc.

Operating Controls

MOTOR STARTERS.—The liquid oxygen pump motor starter and the fan motor starter are identical. Each starter has two button switches; the black button is START, and the red button is STOP. Press the START buttons to turn motors on. Press the STOP buttons to turn motors off.

VAPORIZER SHIFT VALVES.—Four diaphragm, packless, globe valves, mounted on the vaporizer valve manifold, are used to reverse the direction of flow of oxygen through the vaporizing coils. Reversing the flow becomes necessary when discharge oxygen to the charging manifold becomes too cold or visual indication shows the end of the coils are excessively frosted. Valves numbered 1 and 4 and valves numbered 2 and 3 are operated as pairs. When valves 1 and 4 are closed and valves 2 and 3 are open, oxygen flows through the coils from left to right or in the same direction as the airflow. By closing valves 2 and 3 and opening valves 1 and 4, the direction of oxygen flow is reversed through the coils (opposite airflow).

PUMP DRAIN VALVE.—The pump drain valve is a packless, diaphragm, angle valve which is used to drain all oxygen from the pump when extended periods of shutdown are required and when repair of the system is necessary. It is also used during the cooling down process to vent off vaporized liquid oxygen.

MASTER SHUTOFF VALVES.—Two manually operated high pressure, packed, globe valves are installed in the charging manifold. They direct the flow of oxygen gas to the manifold valves. Each valve controls six manifold valves. By opening one valve and closing the other, six cylinders may be alternately charged from each half of the manifold.

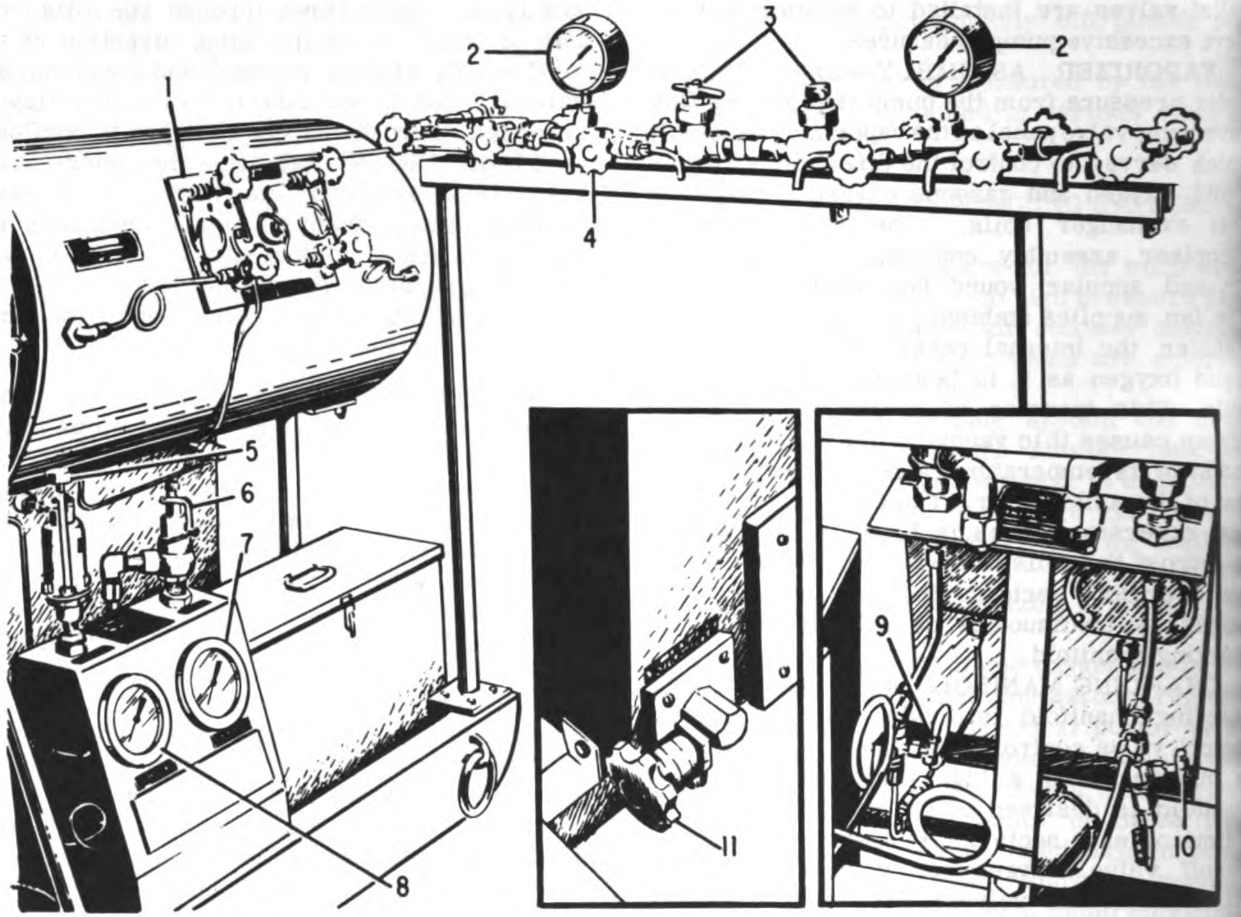
MANIFOLD VALVES.—Twelve manually operated high pressure, packed, angle valves are installed on the charging manifold. They control oxygen gas flow to each pigtail and attached cylinder. To charge a cylinder the valve is opened. After the cylinder is charged the valve is closed. A frangible disc and a fusible plug are incorporated in each valve as overpressure safety devices. The fusible metal plug will melt at a temperature of 208° to 220° F.

PUMP VENT AND PRIMING VALVE.—A pump vent and priming valve is installed in the low pressure outlet line to the low pressure oxygen gage and relief valve. It is used to vent vaporized liquid oxygen during initial startup, when the pump is being cooled down.

LOW PRESSURE LIQUID OXYGEN RELIEF VALVE.—A bronze, spring loaded relief valve is installed on the gage panel. It is set to relieve the pump jacket, inlet line, and vent line from pressures in excess of 90 p.s.i.

HIGH PRESSURE RELIEF VALVE.—A bronze, spring loaded relief valve, installed on the gage panel, is set to relieve pump discharge pressure in excess of 3,100 p.s.i.

GAGE SHUTOFF VALVES.—A high pressure, packed, brass needle valve is installed in the line to each liquid oxygen pressure gage. These valves are used to shut off pressure to the gages if it becomes necessary to replace the gages during system operation.



1. Vaporizer shift valve panel.
2. High pressure gaseous oxygen gage.
3. High pressure oxygen gas master valve.
4. High pressure gas manifold valve.
5. High pressure relief valve.
6. Low pressure relief valve.
7. Low pressure gage.
8. High pressure gage.
9. Low pressure oxygen gage valve.
10. High pressure oxygen gage valve.
11. Liquid oxygen pump drain valve.

Figure 7-6.—Controls and instruments.

INLET LINE SHUTOFF VALVE.—A bronze, packed, globe valve having an extended stem is stored in the toolbox. This valve is installed in the low pressure liquid oxygen inlet line to the pump. It is used to control the flow of liquid oxygen from the liquid oxygen storage container.

INLET LINE RELIEF VALVE.—A bronze, spring-loaded relief valve, stored in the toolbox, is installed in the low pressure liquid oxygen inlet line, using the bronze tee also provided. This relief valve is to be installed between the liquid oxygen container outlet valve and the inlet line shutoff valve. The relief valve prevents excessive pressure from trapping liquid oxygen between these two valves.

Indicating Instruments

HIGH PRESSURE LIQUID OXYGEN GAGE.—A 3 1/2 inch dial, cast aluminum turret case gage is flush mounted on the gage panel to indicate discharge pressure of liquid oxygen from the pump. The gage is graduated from 0 to 4,000 p.s.i. with 50 p.s.i. increments.

LOW PRESSURE LIQUID OXYGEN GAGE.—A 3 1/2 inch dial, cast aluminum turret case gage is flush mounted on the gage panel and indicates suction or supply pressure of liquid oxygen to the pump. The dial is graduated from 0 to 100 p.s.i.

CHARGING MANIFOLD PRESSURE GAGES.—Two 3 1/2 inch dial, cast aluminum turret case gages are installed on the charging manifold to indicate pressure of oxygen gas being charged into the cylinders. Each gage dial is graduated from 0 to 4,000 p.s.i. with increments of 50 p.s.i.

Operating Procedures

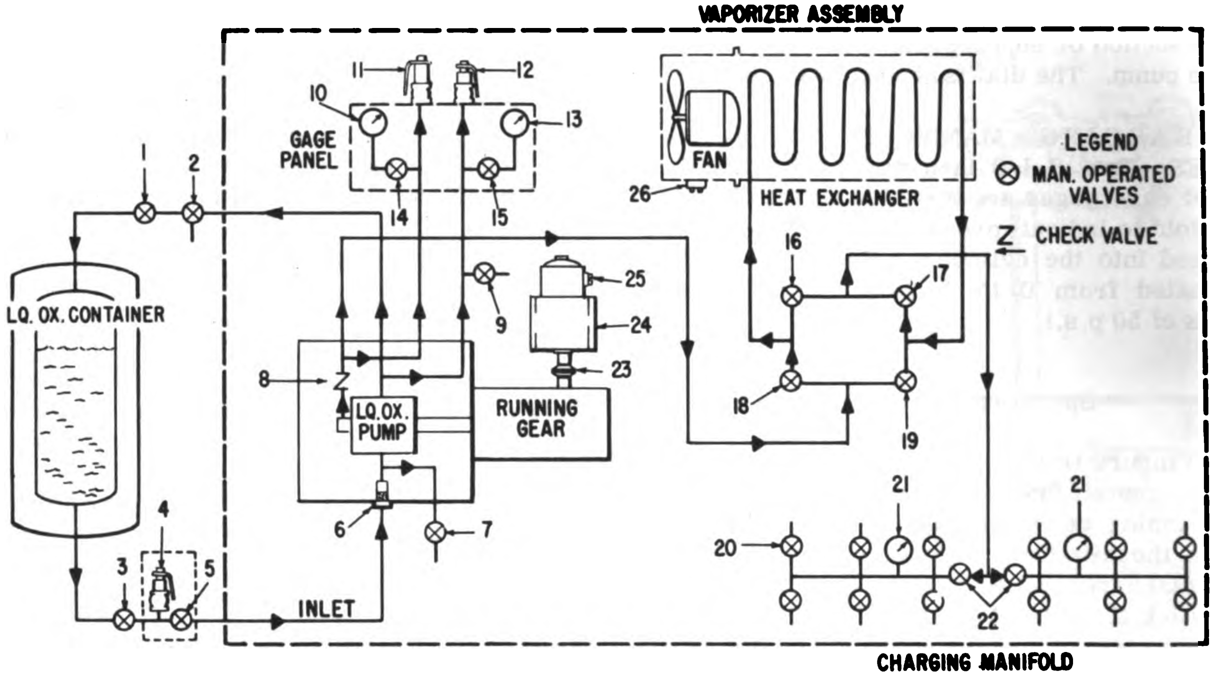
To insure trouble-free operation of the pump, it is essential that the interior of the pump and nlet piping be absolutely free from moisture before the initial starting procedure. The poppet type discharge valve (8, fig. 7-7) in the pump will stick if the least bit of moisture is present. Even traces of moisture can cause the pump plunger to "freeze" in the cylinder since the clearance between plunger and cylinder is very close.

PRELIMINARY PURGING PROCEDURE.—Before placing the pump in operation for the first time, it is advisable that it be purged with oil-free air or nitrogen. Once purged, the plunger moisture seal kept tight and the pump sealed, it will not be necessary to purge the pump again unless the system has been opened to the atmosphere. To purge the pump, proceed as follows:

1. Close the liquid oxygen storage container vent valve (1, fig. 7-7) and the liquid oxygen container shutoff valve (3).
2. Crack open the pump vent and priming valve (9).
3. Loosen the tube connection between shift valve no. 3 (18) and valve No. 1 (16) at valve No. 3. Crack open valve No. 3.
4. Open the pump running gear cover and manually rotate the crankshaft until the pump plunger is in the extreme rear position.
5. Loosen the front clamp (4, fig. 7-8) on the plunger moisture seal (5).
6. Unscrew the cylinder cover nut (3) and carefully slide the nut, clamp, and seal back on the plunger. NOTE: The cylinder cover nut should be handtight only.
7. Disconnect the pump inlet line as close as possible to the liquid oxygen container.
8. Connect a source of dry oil-free air or nitrogen to the pump inlet line.
9. Open the pump vent and priming valve and shift valve No. 3 so that purged air or nitrogen flows equally from these valves and also past the pump plunger V-ring seals.
10. Allow the pump to purge for 30 minutes.
11. After purging, disconnect the source of air or nitrogen and reconnect the pump inlet line to the liquid oxygen container outlet. Install the cylinder cover nut handtight only and tighten the moisture seal clamp on the nut. Close shift valve No. 3 and reconnect the tube to the valve. Close the pump vent and priming valve. Open the liquid oxygen container shutoff and vent valves.

STARTING PROCEDURE.—The initial startup requires a longer period of time than subsequent starts.

1. Rotate the pump running gear manually so that the pump plunger is at the forward end of its stroke. Check the cylinder cover nut (3, fig. 7-8) to see that it is only handtight. The cylinder cover nut screws into the cylinder adapter which contains the V-ring seals.
2. Close the liquid oxygen storage container vent valve (1, fig. 7-7) and open the vapor return line vent valve (2).
3. Open the pump drain valve (7) and the pump vent and priming valve (9). NOTE: The admission of liquid oxygen into a warm pump causes violent vaporization, surging, and pressure buildup. Proceed slowly.
4. Open the outlet valve on the liquid oxygen container about 1/2 turn.
5. After five minutes, open the liquid oxygen container outlet valve one full turn.
6. After ten minutes, open the liquid oxygen container outlet valve two full turns.
7. After 15 minutes, fully open the valve.
8. After 20 minutes, slowly open the liquid oxygen container vent valve and close the vapor return line vent valve.
9. During this cooling down process, observe the pump drain valve—close the valve when liquid flows out. Close the pump and priming vent valve when a steady flow of liquid oxygen is vented. NOTE: No gas will flow from the pump vent and priming valve when the pump is sufficiently cooled down.
10. Leave the vapor return line vent valve open if a minimum head of 18 inches of liquid above the pump inlet will be available while



1. Container vent valve.
2. Vapor return line vent valve.
3. Liquid oxygen container shutoff valve.
4. Inlet relief valve.
5. Inlet line shutoff valve.
6. Pump suction filter.
7. Liquid oxygen pump drain valve.
8. High pressure liquid oxygen pump discharge valve.
9. Oxygen pump vent and priming valve.
10. High pressure liquid oxygen gage.
11. High pressure liquid oxygen relief valve.
12. Low pressure liquid oxygen relief valve.
13. Low pressure liquid oxygen gage.
14. High pressure oxygen gage valve.
15. Low pressure oxygen gage valve.
16. High pressure oxygen vaporizer shift valve No. 1.
17. High pressure oxygen vaporizer shift valve No. 2.
18. High pressure oxygen vaporizer shift valve No. 3.
19. High pressure oxygen vaporizer shift valve No. 4.
20. High pressure oxygen gas manifold valve.
21. High pressure oxygen gas gage.
22. High pressure oxygen gas master valve.
23. Flexible drive coupling.
24. Gearmotor.
25. Motor starter, liquid oxygen pump.
26. Motor starter, oxygen vaporizer fan.

Figure 7-7.—High pressure liquid oxygen vaporizing system schematic.

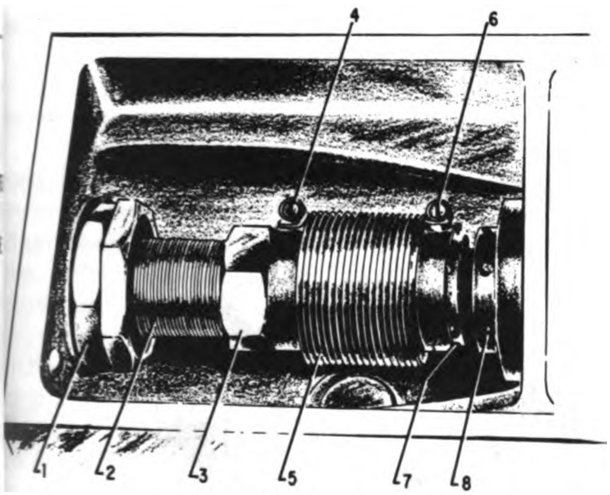
pumping. If this minimum head is not provided or available, close the vapor return line vent valve and slowly crack open the liquid oxygen container pressure buildup valve to obtain and maintain a container pressure of approximately 3 p.s.i. NOTE: Do not build up excessive pressure in the liquid oxygen container.

11. Open one pair of shift valves on the vaporizer valve panel. Leave the other pair closed. Valve Nos. 1 and 4 (16 and 19, fig. 7-7) and valve Nos. 2 and 3 (17 and 18) are pairs.

12. Open all valves on the charging manifold.

13. Press the START button on the fan motor starter (26).

14. Press the START button on the pump gearmotor starter (25). NOTE: A pulsating high pressure oxygen gage and frosting of the pump discharge line indicate the pump is picking up.



1. Cylinder locknuts.
2. Cylinder adapter.
3. Cylinder cover nut.
4. Front clamp.
5. Moisture seal.
6. Rear clamp.
7. Plunger nut.
8. Plunger locknut.

Figure 7-8.—Pump cylinder cover nut and plunger adjustment points.

15. Allow the pump to operate at no load with gas venting out the manifold pigtails for about 1 to 2 minutes, then close all valves. Allow pressure to build up to 3,000 p.s.i. Slowly open all valves and blow pressure down to 0 p.s.i.

NORMAL OPERATING PROCEDURE.—The normal operating procedure is as follows:

1. Connect the pigtails to empty cylinders as shown in figure 7-9.

2. For more efficient and time saving charging operation, charge 6 cylinders simultaneously.

3. Open one master shutoff valve and the respective six manifold valves on one side of the manifold.

4. Open the valve on each cylinder to be charged.

5. Allow six cylinders to charge, then close each cylinder valve, manifold valves, and master shutoff valve.

6. Open the other master shutoff valve and the remaining six manifold valves and cylinder valves. Allow the cylinders to charge on the other side of the manifold.

7. Remove the six charged cylinders from the pigtails while the remaining six are being charged. Connect six empty cylinders in their places. NOTE: Loosen the pigtail connection at each cylinder and allow oxygen trapped in the manifold and in the pigtails to escape before removing the charged cylinders.

8. Alternate the charging of cylinders from one side of the manifold to the other side. Make certain to close master shutoff valve and the six cylinder shutoff valves before removing the charged cylinders.

9. Observe the outlet line from the vaporizer to the manifold. When it just begins to frost, change the flow direction of oxygen through the vaporizer by closing the open pair of vaporizing shift valves and quickly opening the closed pair. NOTE: After changing flow direction, the outlet line and manifold may frost for a short period of time, but the defrost feature of the heat exchanger will soon bring them up to normal temperature.

10. During operation, check the cylinder cover nut for handtightness only. NOTE: During operation, the cylinder cover nut and the exposed end of the cylinder adapter will be frosted. (See fig. 7-8.) This condition is normal.

11. Continued operation of the unit requires only the alternate charging of cylinders (see step 8 above) and reversing the flow direction of oxygen through the vaporizer (see step 9 above).

12. If the liquid oxygen storage container is pressurized and the vapor return line vent valve is closed (see step 10 above), the pressure in the container must be maintained. If the pressure drops, bring it up with the pressure building coil and valve. Open the pressure buildup valve slowly and observe the liquid oxygen container pressure gage. Close the buildup valve when the desired pressure is reached. NOTE: If the liquid oxygen container pressure is too high and continues to increase when the buildup valve is closed, crack open the vapor return line vent valve just enough to maintain the desired pressure. A steady nonfluctuating pressure gives best pumping results.

SHUTDOWN PROCEDURE.—The shutdown procedure is as follows:

1. If the liquid storage container is pressurized and the pump must be shut down for a period of one or two hours, press the STOP button on the pump motor starter (25, fig. 7-7); leave the fan on until the vaporizer coils are completely defrosted; then press the STOP button on the fan motor starter (26). Leave other controls as they are.

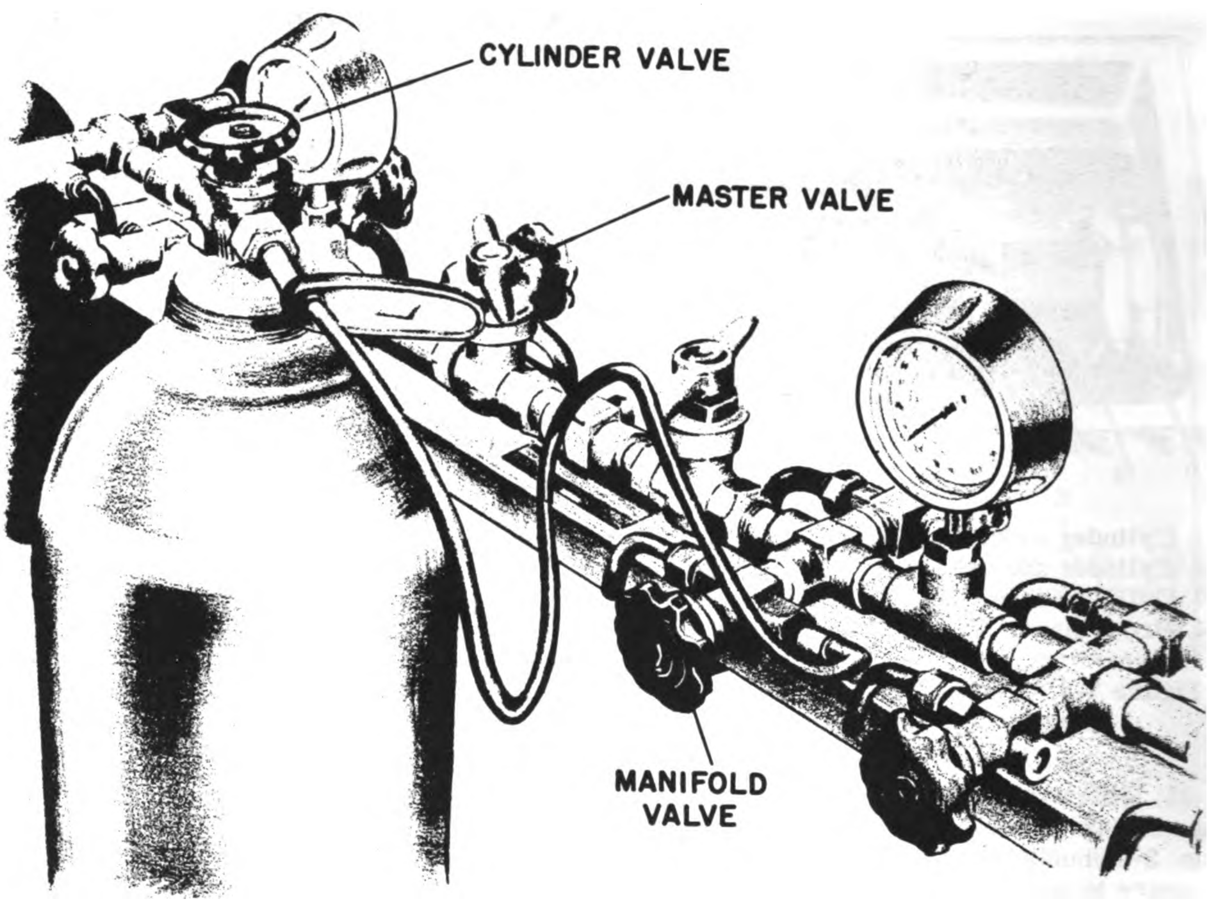


Figure 7-9.—Cylinder connected to pigtail.

2. If the liquid oxygen container is pressurized and the pump must be shut down more than two hours, perform the following:

a. Press the STOP button on the pump motor starter.

b. Close the liquid oxygen container shutoff valve (3).

c. Open the vapor return line vent valve (2) and blow down pressure in the container to 0.

d. Defrost the vaporizer coil by leaving the fan on.

e. Open the pump drain valve (7), and using pressure in the system, blow all liquid oxygen out of the system.

f. Open the pump vent and priming valve (9) and blow off any residual gas.

g. Open the manifold master valves (22) and one manifold valve (20) on each side to blow down the vaporizer and manifold.

h. Press the STOP button on the fan motor starter after the vaporizer coils are completely defrosted.

3. If the liquid container is not pressurized, perform procedures as described in steps 1 and 2 above, except for blowing down the pressure in the liquid oxygen container.

Maintenance

Maintenance of the system is limited to cleaning and replacement of the pump suction filter, adjusting the pump plunger head, adjusting for valve packing leaks, and replacement of packing and damaged parts. Complete instructions are contained in NA 19-5-501.

CLEANING PUMP SUCTION FILTER.—Periodically, the pump suction filter should be removed, cleaned, and reinstalled. This procedure follows:

1. Close the pump inlet shutoff valve.
2. Close the liquid oxygen container vent valve if the container is pressurized.
3. Open the pump drain valve and drain all liquid oxygen from the pump. CAUTION: Provide adequate ventilation and remove all flammable material from the area before draining. DO NOT SMOKE. Wear grease- and oil-free clothing.
4. Disconnect the liquid oxygen inlet line fitting from the pump inlet adapter at the side of the pump insulation box.
5. Reach into the inlet adapter with a pair of snapring pliers, and remove the filter retaining ring, and slide out the filter. (See fig. 7-10.)
6. Clean the filter in trichlorethylene (MIL-T-7003) and dry thoroughly with clean, dry, compressed air.
7. Reinstall the filter and secure with the retaining ring.
8. Connect the pump inlet line and open the shutoff valve. Close the pump drain valve when liquid appears. NOTE: Use a light coat of thread-sealing compound (MIL-T-5442B) on threaded male fittings. Leave the two leading threads bare to avoid introducing unnecessary foreign material into the system.

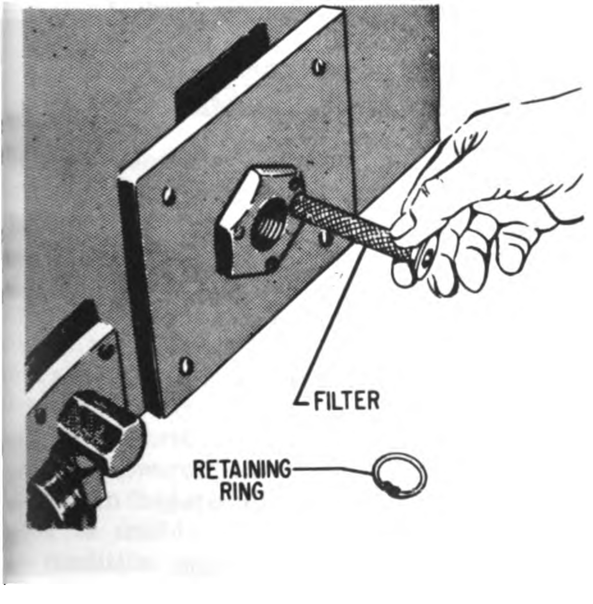


Figure 7-10.—Removing pump suction filter.

LIQUID OXYGEN STORAGE TANKS

Liquid oxygen storage tanks having capacities ranging from 150 to 2,000 gallons are used at naval shore activities. The 150- and 500-gallon sizes are normally skid mounted and semipermanently installed, while the 450- and 2,000-gallon sizes are permanently installed. Figure 7-11 illustrates a typical 500-gallon installation.

Some fleet units operating independently of fixed facilities have been supplied with 150- and 500-gallon trailer-mounted tanks. These tanks serve the purpose of receiving, holding, transporting, and dispensing liquid oxygen. In addition, 150-gallon trailer mounted tanks have been supplied to some permanent stations when it is more economical for the facility to provide its own delivery service.

All liquid oxygen storage tanks are basically similar, regardless of their size or configuration, and whether they are skid mounted, trailer mounted, or permanently installed. They all consist of an inner and outer container separated by an annular insulated space that is packed with a powder-type insulating material and evacuated to a high degree in order to minimize heat transfer and thereby hold the evaporation losses to a minimum. The following major components are necessary for the proper operation of the tanks. (See fig. 7-12.)

1. Pressure gage (4), which indicates the internal pressure of the tank that has built up because of evaporation of the liquid oxygen within the tank.
2. Capacity gage (16), which indicates the quantity of liquid in the tank.
3. Vacuum gage (2), which indicates the vacuum pressure in the insulation space.
4. Fill-drain line (11) and valve (17), which permit liquid to pass during filling or draining operations. Storage tanks of latest design incorporate a separate top fill line which reduces filling losses and permits simultaneous filling and discharging of liquid oxygen.
5. Vent line (7) and valve (3), which in conjunction with a relief valve set at 60 p.s.i., permit escape of the evaporated oxygen and prevent pressure buildup when the tank is not in use. The vent valve, while closed, permits the buildup of pressure for transferring operations.
6. Pressure buildup coil (21) and valve (13), which permit the liquid to flow out of the tank into the buildup coil, evaporate, and pass back

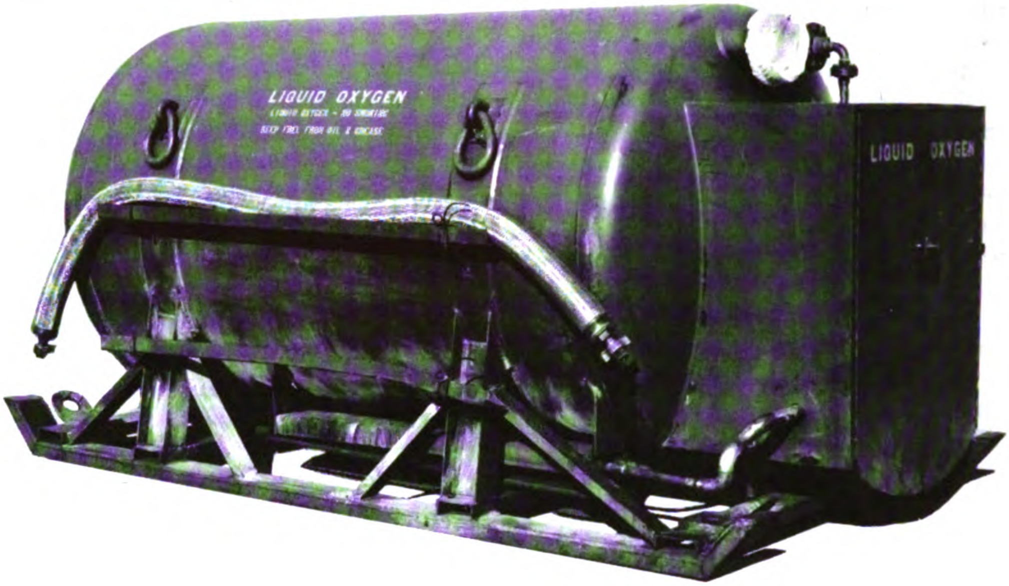
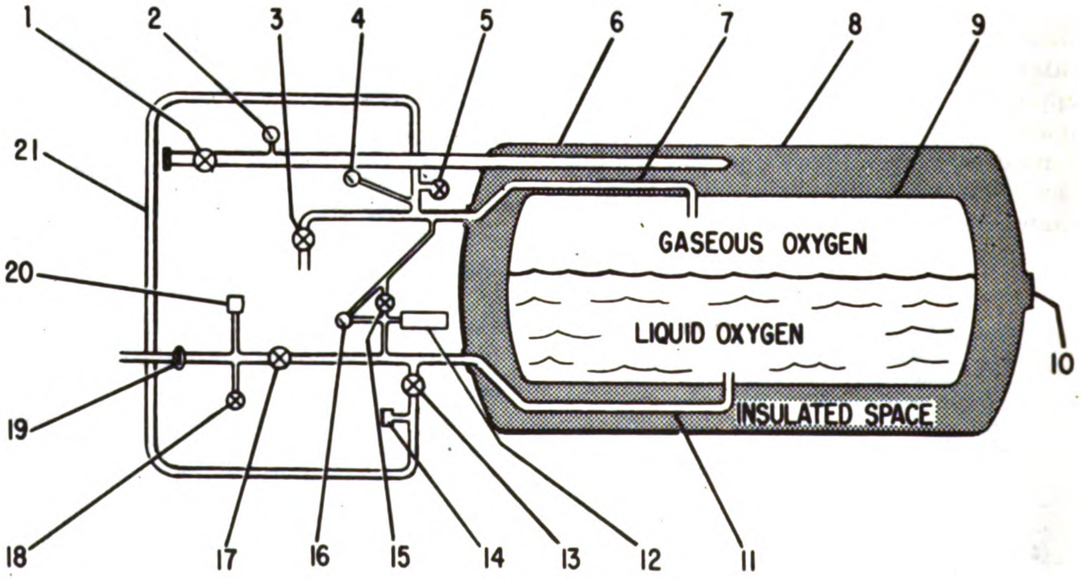


Figure 7-11.—Typical liquid oxygen storage tank.



1. Vacuum valve.
2. Vacuum gage.
3. Vent valve.
4. Pressure gage.
5. Tank pressure relief valve.
6. Vacuum line
7. Vent line.
8. Outer tank.
9. Inner tank.
10. Rupture disc.
11. Fill drain line.
12. Dampener tank.
13. Pressure buildup valve.
14. Safety disc.
15. Capacity gage bypass valve.
16. Capacity gage.
17. Fill drain valve.
18. Hose pressure relief valve.
19. Filter.
20. Hose pressure safety disc.
21. Pressure coil.

Figure 7-12.—Control hood arrangement of liquid oxygen tank (Ronan and Kunzel, Type MA-1).

into the gas phase of the inner tank in order to provide an operational pressure with which to transfer liquid oxygen from the tank.

7. Vacuum line (6) and valve (1), which permit establishment of the vacuum in the insulation space.

8. Relief valves (5 and 18) and rupture discs 10 and 14), which relieve excessive oxygen pressures and provide emergency outlets.

9. Full tryline and trycock, which determine when the level of liquid desired has been reached during filling of the tank. If these are not provided, the vent line may be used. Usually, the desired level allows 10 percent gas space for expansion of the liquid.

Maintenance

Inspect all parts for cleanliness, signs of wear, and damage. Clean dirty parts as necessary and replace any part that shows signs of wear. WARNING: To minimize danger of explosion use no oil or grease whatever on individual parts and assemblies of the tank. Safety precautions should be followed by all personnel responsible for the handling of liquid and gaseous oxygen. To insure the safety of personnel and the safe and efficient handling of liquid and gaseous oxygen, all personnel should be thoroughly familiar with the characteristics of liquid oxygen and gaseous oxygen.

OXYGEN HANDLING SAFETY PRECAUTIONS

Compressed oxygen and any flammable substance can unite with explosive results, the extent of this danger depending upon the conditions of concentration, pressure, temperature, and confinement. The main ingredient for spontaneous combustion lies in the attainment of a burning temperature. (The temperature at which a material will burn.) Applied concentrations of pure oxygen in an enclosed area where burnable material is present will result in an explosion. Danger exists in the accumulation of heat when the heat of a rapidly oxidizing hydrocarbon is unable to be carried off normally. This condition generates an excessive amount of heat which is capable of bursting into flame with great force and heat, depending on the kind of material affected and its area of confinement.

Oxygen while not flammable in itself is the principal supporter of combustion; and since concentrated or pure oxygen greatly intensifies burning or the oxidation of any hydrocarbon, it is easy to understand the seriousness of the situation when the oxygen pressure is increased. Certain hydrocarbons are naturally more susceptible to burning than others; and when pressurized oxygen gas is carelessly sprayed on quantities of volatile liquids or paste, the reaction is one of accelerated oxidation. The oxidation is accelerated at such a tremendous rate that the flashpoint of the material is reached almost instantly, and an explosion equal to the energy of TNT results.

KEEP OIL AND GREASE AWAY FROM OXYGEN AND OXYGEN EQUIPMENT. This is the primary rule to remember. It implies every conceivable precaution to be taken when a man is working in the shop or in an aircraft. Sometimes danger is not apparent until a badly flexed and weakened high pressure line breaks while transferring oxygen in the fuselage of a dirty and oily aircraft. Look for a place where oil and grease may accumulate or collect, and take remedial action to prevent its coming in contact with oxygen. In working with oxygen, it is easy to overlook troublesome areas and become careless. Either keep the filler lines clean and clear or keep oxygen away from such lines.

A list of general safety precautions follows:

1. When attaching an oxygen transfer line, always make certain the connections are clean, dry, and in good condition before cascading or pumping oxygen.
2. When cascading or pumping oxygen, have someone standing by who can positively shut off the flow in the event of an emergency.
3. Handle cylinders carefully and never drop or bump them.
4. Never use cylinders as rollers for moving heavy equipment.
5. Do not drag or slide cylinders across a deck or the ground.
6. Never mix oxygen with other gases.
7. Never completely expend the supply of oxygen from a cylinder. Always leave a residual pressure in excess of 15 p.s.i.
8. Do not leave oxygen cylinders near any extreme source of heat.
9. Never fill a lower pressure capacity cylinder without an approved pressure reducing valve.

10. Never use any piece of equipment before understanding its purpose and use.

11. Always check the latest hydrostatic test data stamped on the neck of a cylinder.

12. Always check to make certain the cylinder has been tested for chlorinated hydrocarbons.

13. Never overfill a system.

14. Never leave a trailer cascading system turned on after use.

15. Never leave filling connections exposed to the weather.

16. Never set a filling connection down on the deck or ground.

17. Once pressure is on a flexible filling line, never let go of it.

18. Always replace protective thread and end-of-line caps.

19. Never use oxygen filler lines for any gas other than pure dry oxygen, nitrogen, or water pumped dry air. (Water pumped air does not contain the slightest trace of oil or grease, and is usually more difficult to obtain than the nitrogen.)

20. Never use anything but an approved cleaning agent for cleaning external oxygen fittings.

21. Never permit the use of electromagnets in handling oxygen cylinders.

22. Never hoist oxygen cylinders with rope or chain slings. Handle with cranes and specially built cradles, using cable straps to protect them from shifting.

23. When transporting in trucks, storage cylinders should be securely fastened together in an upright position.

24. Protect stored cylinders from excessive temperatures. (Maximum temperature 130° F.)

25. Protect cylinders from the direct rays of the sun.

26. In winter protect cylinders from snow and the formation of ice.

27. Keep cylinders away from flammable materials.

28. Store empty cylinders separately from the full cylinders.

29. Tag or mark empty cylinders. Cylinders are considered empty when less than 50 p.s.i. of pressure remains.

30. Always replace protective valve caps on storage cylinders when they are not in use.

31. Never use greasy rags or wear greasy clothes, or cosmetics (hair oil, lip salve etc.), when working around oxygen equipment.

The following additional precautions are applicable specifically to the handling of liquid oxygen.

1. Do not operate liquid oxygen equipment unless you are qualified or are working under the supervision of qualified personnel.

2. Wear goggles or a face shield when handling liquid oxygen.

3. Do not handle with bare hands any tubing or fittings through which liquid oxygen is flowing. Wear clean, dry gloves when handling parts of equipment cooled by liquid oxygen.

4. In the event that liquid oxygen is spilled on clothing, remove the clothing immediately. In case the body comes in contact with liquid oxygen, or there is reason to suspect some part of the body has been frozen or chilled, follow the first aid instructions on the nearest first aid kit.

5. Do not permit smoking, open flames, or sparks in the liquid oxygen handling areas.

6. Do not carry matches in liquid oxygen handling areas.

7. Keep work area and equipment free from oil, grease, or any other combustible material.

8. Keep tools and clothing free from oil and grease.

9. Avoid spilling liquid oxygen on floor or deck areas. In case of accidental spillage, thoroughly ventilate the area.

10. Always call oxygen by its proper name. Do not confuse it with compressed air. Never use oxygen in place of compressed air for any purpose.

11. Handle converters, storage tanks, and transfer hoses with care to avoid damage to the insulating space.

12. When transferring liquid oxygen, do not leave valves open all the way. Open valves wide, and then immediately close them about one quarter turn; otherwise they may freeze in the open position.

13. Disconnect filling or transfer lines as soon as the transfer process is completed.

14. Do not leave liquid oxygen in a closed container or trapped in a line between two valves; always open a valve on one end to avoid excessive pressure buildup.

15. Use only standard approved equipment in the handling and storage of liquid oxygen.

16. Do not introduce moisture into the sys- m. Exercise care to insure that no moisture present on filler valve nozzles when they are nnected or disconnected.

17. Purge piping and equipment with dry, -free air or nitrogen before and after making y repairs.

18. Where connection is to be made in con- ed areas or overhead, protect eyes with a e shield or safety goggles. For adequate otection, use safety glasses with side shields. ways wear gloves when handling any equipment it is or may have been in recent contact with uid oxygen. Leather gloves are preferable, but asbestos gloves may be used if they are treated or lined to prevent the penetration of any splashed liquid. Gloves should be loose fitting so they can be thrown off quickly should any of the liquid get into them. An apron of asbestos, leather, rubber, or plastic should also be worn, in addition to high-top shoes. Cuffless trousers should be worn outside the shoes. In general, all clothing should be worn so that in the event of spillage, the liquid will roll off the clothing and not become trapped in gloves, shoes, or pockets. Any clothing that becomes splashed or soaked with liquid oxygen should be removed immediately and promptly aired.

CHAPTER 8

TESTING OXYGEN

Aviator's breathing oxygen must be pure and it must be dry. The importance of this fact cannot be overemphasized. Lives of pilots and aircrewmen depend on it.

Impure breathing oxygen is dangerous at all altitudes. The moisture content becomes dangerous when the ambient (surrounding) temperature is low enough to freeze the droplets in an aircraft oxygen system. Therefore, aviator's breathing oxygen used in today's high-performance aircraft must be both pure and free of moisture.

Since it is so important to have pure, dry oxygen, a systematic schedule of tests must be made to insure that breathing oxygen meets the required standards outlined in the previous chapter, and that it remains that way until ready for use.

This chapter covers the laboratory instruments commonly used in making these inspections. For more detailed information on the operation and maintenance of these instruments, reference should be made to the applicable Operation and Service Instruction Manual. All available manuals on oxygen test equipment are listed by title and publication number in the *Naval Aeronautical Publications Index* under "Machinery, Tools, and Test Equipment" (17 series).

WATER VAPOR INDICATORS

Measurement of the moisture content of aviator's breathing oxygen is made with a water vapor indicator. (See fig. 8-1.) This instrument was developed during World War II and is suitable for measuring the moisture content of other gases such as nitrogen, CO_2, air and helium, as well as breathing oxygen.

Aminco-Weaver Water Vapor Indicator

The water vapor indicator described in this section is manufactured by the American Instrument Company, Silver Spring, Maryland, and is identified as the Aminco-Weaver Water Vapor Indicator.

PRINCIPLES OF OPERATION.—The Aminco-Weaver Water Vapor Indicator is shown in schematic diagram form in figure 8-2. Water vapor content of the test gas is determined through comparison with the water vapor content of a standard gas, saturated under pressure, and expanded to atmospheric pressure.

A measure of the water vapor content of the standard gas (gas supply connected to saturator) is derived by using a moisture sensitive detector. The pressure of the test gas is adjusted until it like gas, Pa, test gas pressure, Px, altitude, and ambient (prevailing and surrounding) temperature are related, using the moisture calculator for determining the water vapor content of the test gas.

The tip of the detector, which is exposed to moisture-laden gas, is coated with a thin hygroscopic film of electrolyte. In operation, water molecules impinge upon this film and the number striking it determines the electrical resistance of the film. Acting in this capacity, the moisture sensitive detector constitutes one arm of an alternating-current (a-c) bridge. (The principles of an electrical bridge are discussed and illustrated in *Basic Electricity*, NavPers 10086-A.) A vacuum tube voltmeter is used to determine unbalanced conditions in the bridge where the detector is serving as one arm of the arrangement. The indicating microammeter will show resistance changes in the detector tip. Therefore, the meter reading changes if the water vapor content of the gas changes.

An audio oscillator furnishes a-c power to the bridge circuit. Batteries (two 45-volt batteries and one 1 1/2-volt battery) are contained within the unit, making external power unnecessary. Mechanically, the instrument consists of equipment to produce a standard gas of known water content and to control the pressure of the test gas.

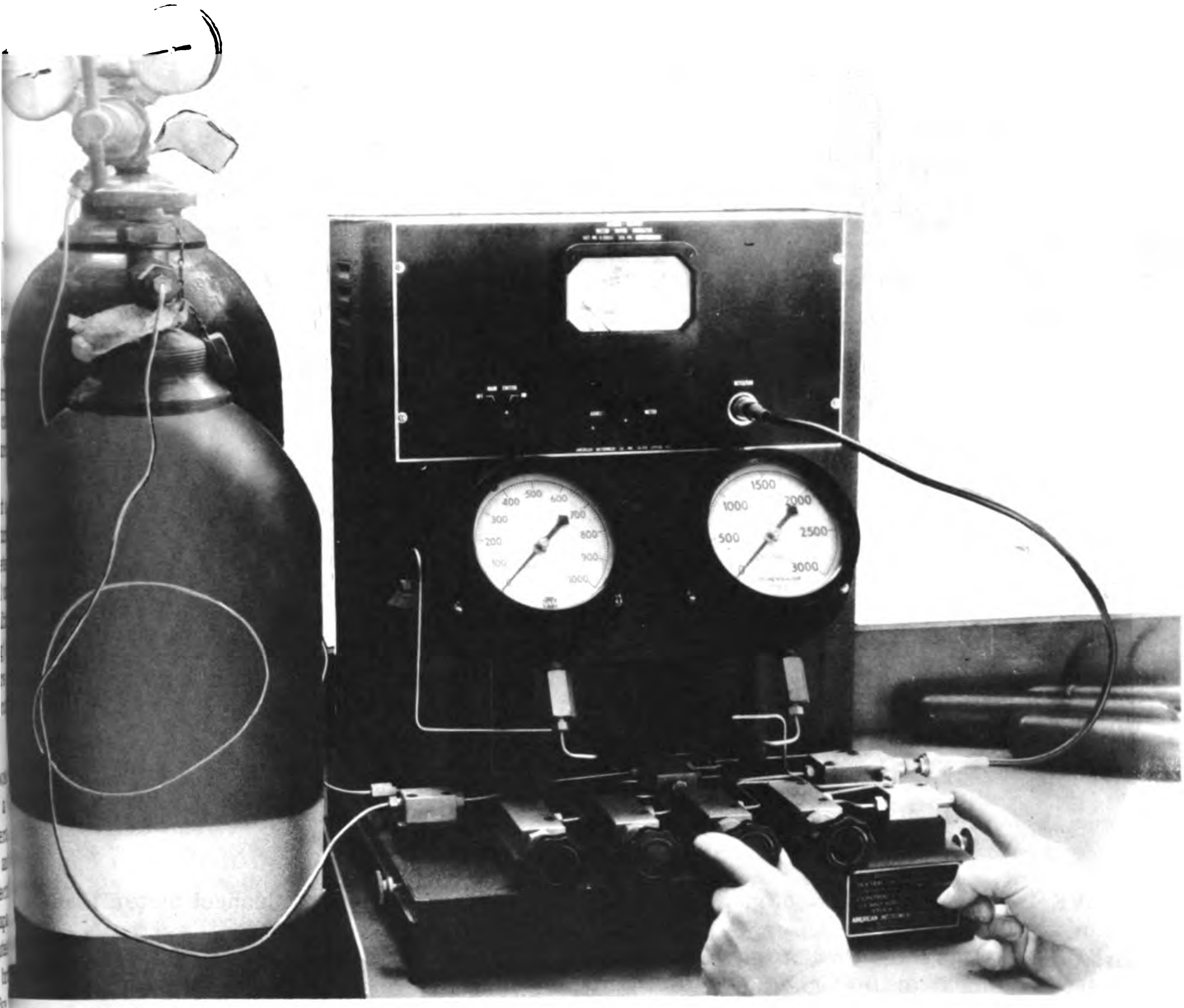


Figure 8-1.—Water vapor indicator.

The water vapor indicator measures water vapor content of compressed gases within the range of 0.005 to 1 milligram per liter computed at 80° F. and atmospheric pressure. The accuracy of the instrument is ± 10 percent of the amount of water vapor present.

DESCRIPTION.—The water vapor indicator consists of a main assembly shown in figure 8-3, and the accessories, shown in figure 8-4. The main assembly includes the electronic chassis and control panel, saturation and test gas pressure gages, saturator, double-tee inlet, outlet and detector blocks, and four control valves. The accessories can be stored in a cabinet which is in back of the main assembly.

The controls of the instrument and their functions follow:

MAIN SWITCH—a two-position switch. When in the OFF position, the equipment is inoperative; when in the ON position, it connects the batteries making the equipment operative.

ADJUSTMETER—adjusts indicating meter to any value whether the detector is connected or not.

VALVE A—adjusts the flow of gas from the test gas cylinder to the detector block.

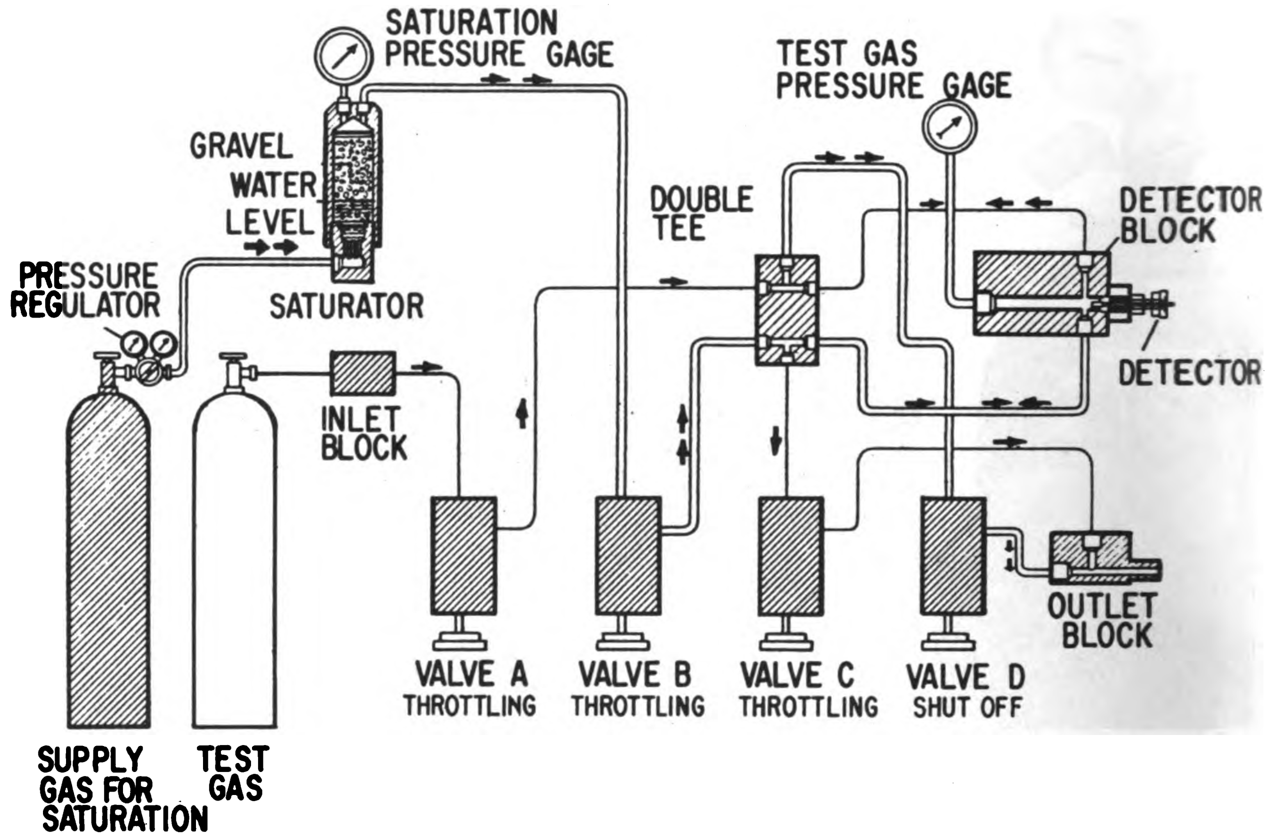


Figure 8-2.—Schematic diagram of the water vapor indicator.

VALVE B—adjusts the flow of gas from the saturator to the detector block.

VALVE C—adjusts the flow of test gas from the detector block to the gas outlet block.

VALVE D—adjusts the flow of standard gas from the detector block to the gas outlet block.

The functions of the dial instruments follow:

METER—indicates resistance of detector. If the meter adjustment control is not changed and resistance of the detector is constant, the meter reading remains unchanged.

SATURATION PRESSURE GAGE—indicates pressure in the saturator.

TEST GAS PRESSURE GAGE—indicates pressure in the detector block.

OPERATING PROCEDURE.—Operating steps follow:

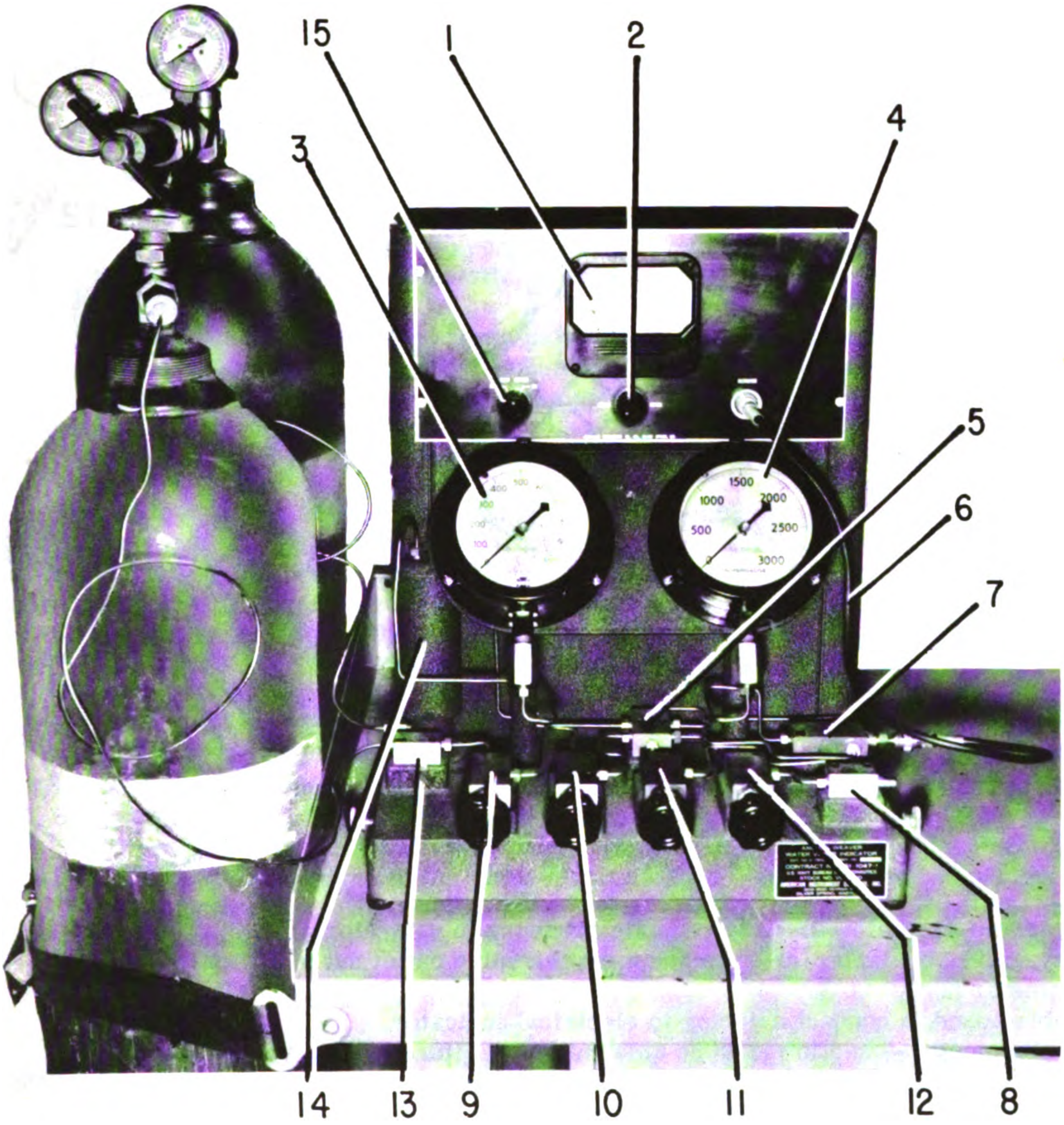
1. Unscrew and remove the four cover retaining screws and remove the cover. Remove the sheet metal screws in top of electrical indicator and remove the top. Remove the meter shorting wire which bridges the two terminals in back of the meter. Connect meter leads and replace the top.

2. Remove accessories from back of instrument.

3. Connect the pressure reducing regulator to the supply cylinder of the standard gas supply. Next, connect one end of the pressure reducer-saturator line by screwing the end fitted with the long nut into the bottom of the saturator. Use wrench (13, fig. 8-4) to complete tightening nuts on 1/8-inch tubing. Designed to prevent stripping the threads when tightening such connections, this wrench offers limited leverage possibilities.

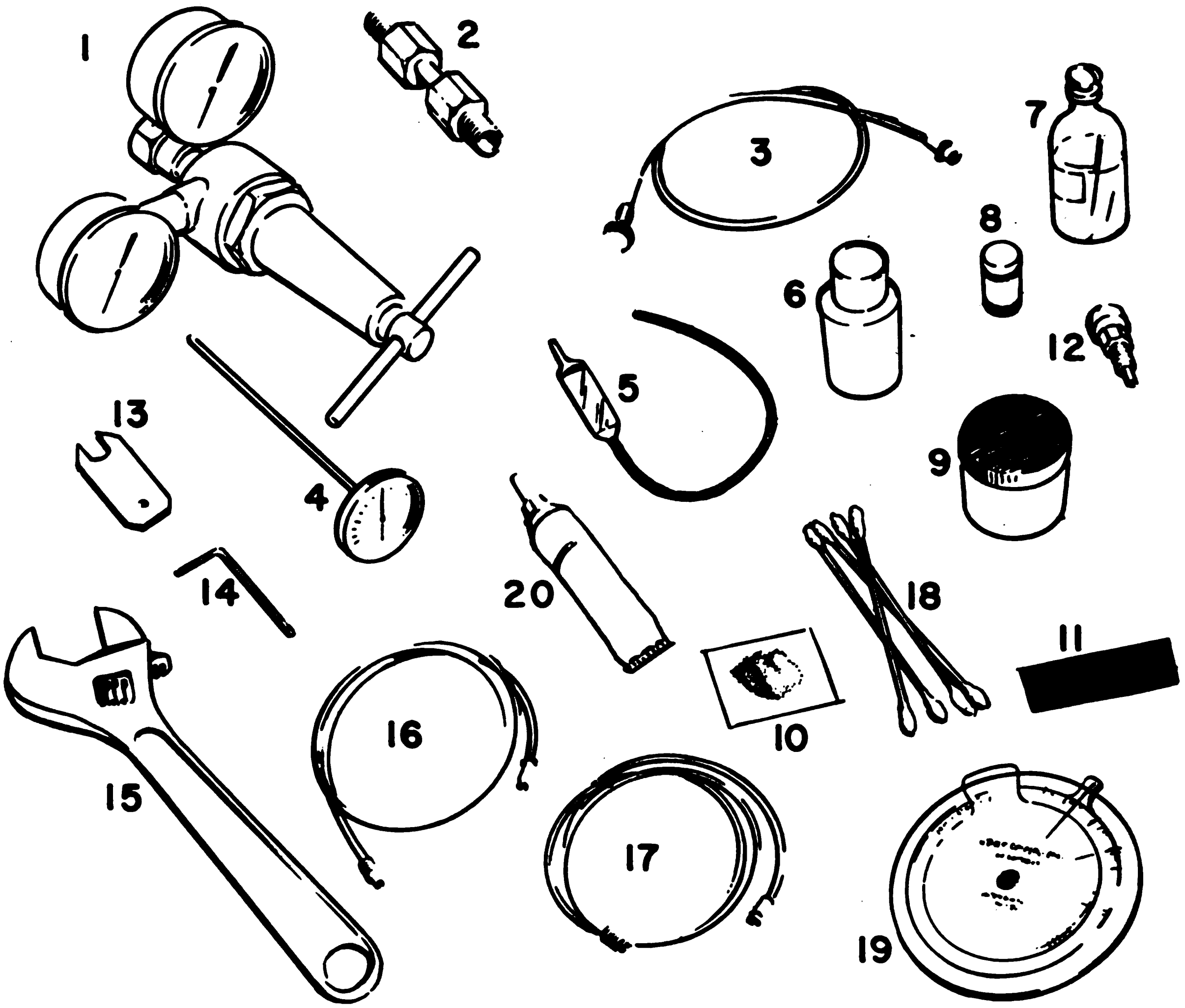
4. Connect valve adapter to the test gas cylinder valve; follow this by engaging the cylinder-inlet-block line between the valve adapter and the inlet block connections.

5. To add water to the saturator, disconnect the two lines leading into its top, thus exposing the threaded holes. Fill pipette with distilled water (about 20 ml. (milliliter)) by sucking on



1. Microammeter
2. Adjustmeter.
3. Saturation pressure gage.
4. Test gas gage.
5. Double tee.
6. Cable.
7. Detector block.
8. Outlet block.
9. Valve A.
10. Valve B.
11. Valve C.
12. Valve D.
13. Inlet block.
14. Saturator
15. Main switch.

Figure 8-3.—Front view of water vapor indicator—cover removed.



1. Pressure regulator—used to regulate pressure in saturator.
2. Oxygen valve adapter—used to adapt oxygen valve outlet nut to standard 3/8-inch diameter nut.
3. Cable—used to connect detector to electrical indicator.
4. Thermometer—used to measure ambient temperature around equipment.
5. Pipette—used for adding water to saturator. (With care, a hypodermic syringe fitted with a long needle can also be used).
6. Phosphoric anhydride—forms phosphoric acid (alternate electrolyte) when exposed to water. The resulting acid is a sirupy hygroscopic liquid and is placed on the detector when moderately dry gases are being measured for water content.
7. Electrolyte—this liquid is made up of 3 parts phosphoric acid and 1 part sulphuric acid; it serves as hygroscopic material when placed on tip of the detector (varies in resistance with water vapor content of gas surrounding it). Used when very dry gases are being measured for water content. (Aviator's breathing oxygen is supposed to be very dry for reasons already familiar to Parachute Riggers.)
8. Vial—used to protect expensive and delicate detector.
9. Jar—used to hold aloxite grinding compound.
10. Grinding compound—aloxite fine grinding compound grit No. 95, used to grind tip of detector.

Nomenclature for figure 8-4—Continued

11. Grinding plate—used to hold grinding compound while grinding detector tip (any microscope glass slide may be used).
12. Detector—used to detect water vapor, and must be handled with care.
13. Wrench—W-1—used to tighten nuts on flow assembly and tighten detector in block.
14. Wrench—W-2—used to remove valves, detector block, gas outlet and inlet block, double tee, and saturator from base.
15. Wrench—W-3—used to tighten pressure regulator to cylinder of supply gas for saturator, to tighten oxygen valve adapter to test gas cylinder, and to tighten gland nuts of valves A, B, C, and D.
16. Pressure reducer-saturator line—used to connect pressure regulator to saturator.
17. Cylinder-inlet-block line—used to connect oxygen cylinder to inlet block.
18. Applicators—cotton tipped wooden sticks, used to apply and remove excess electrolyte from detector.
19. Moisture calculator—used to calculate moisture content of test gas.
20. Grease—Dow Corning 33 grease of medium consistency used to grease threads and tips of valves A, B, C, and D whenever instrument has been disassembled for baking out or cleaning.

Figure 8-4.—Instrument accessories.

the glass tip while the end of the rubber tube is immersed in the water. When the quantity s reached, quickly trap the water in the pipette and clamp the end of the rubber tube with the fingers. Transfer the liquid into the saturator THROUGH THE HOLE USED TO CONNECT THE SATURATOR TO THE SATURATION PRESSURE GAGE. IF ANY WATER ENTERS THE OTHER HOLE CONNECTION, IT MUST BE REMOVED. This can be accomplished by swabbing out the water with cotton tipped applicators, a slow process, but one that must be accomplished. Replace and tighten the lines removed from the saturator. Figure 8-5 illustrates a cross sectional view of the saturator.

6. Connect the free end of the pressure reducer-saturator line to the pressure reducer.

7. Apply electrolyte sparingly by dipping the wood end of the applicator in the compound and touching it to the tip of the detector. A small ball of the electrolyte will be formed. To remove excess acid, make two or three light pressed strokes over the tip of the detector with the cotton end of the stick. When the excess has been removed sufficiently, the tip will appear dull but not quite dry. The film thickness remaining on the detector is not critical. One film might offer five times the resistance of another, but their difference would be hardly noticeable in use.

Break off the tip of the stick so that it will not come in contact with the person or clothing. One applicator can be used repeatedly by breaking off the previously applied portions. To minimize spillage, use only a small quantity of the acid in the bottle at any one time.

8. Insert the detector into the detector block and tighten it with the stubby wrench.

9. Close all valve blocks (A, B, C, and D).

10. To prevent a pressure surge from blowing water out the saturator into the dry lines and valve blocks, release the pressure adjusting screw on the pressure regulator by rotating it counterclockwise until it spins freely. CAUTION: Careless valve handling procedures will dampen or saturate the system, making it necessary to strip and bake the lines and blocks before the instrument can be reset for use. Therefore, make it a habit to open all valves very slowly. Crack (open a fraction of a turn) the cylinder valve of the saturator gas supply. After the cylinder pressure gage stops indicating, open the valve fully.

11. Rotate the adjusting screw on the pressure reducing regulator, and slowly build up the pressure in the saturator to 700 p.s.i. as indicated on the pressure gage. Pressure up to 1,000 p.s.i. has been found to offer a reliable testing pressure. Here, too, smooth operation in the pressure buildup procedure is important to prevent blowing water into the lines.

12. Open valve D completely.

13. Open valve B about 1/8 of a turn; gas should now be flowing slowly from the outlet block. Adjust the valve so that the flow of

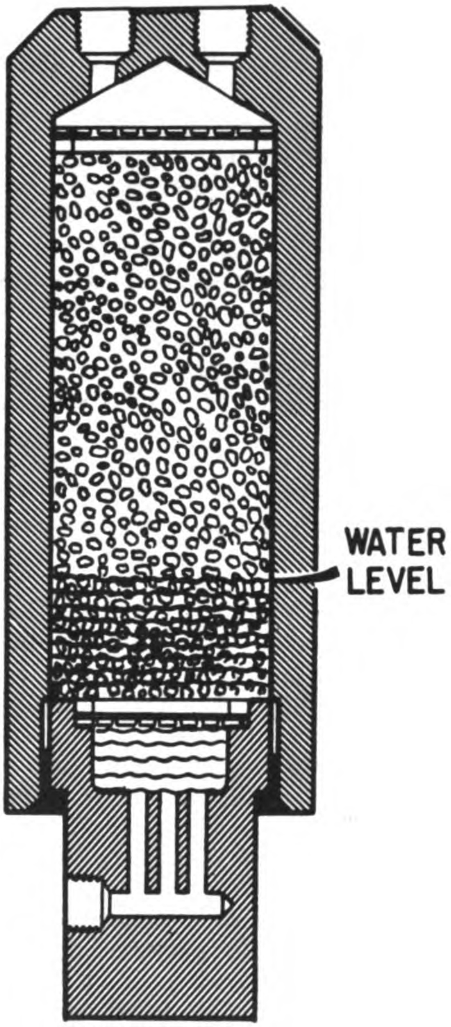


Figure 8-5.—Saturator.

gas is barely noticeable, emerging from the outlet. To test the adjustment of the very low flow, block the outlet with the finger. After a few seconds of blocking the outlet, and if there is a flow in the system, the pressure will have increased enough for the gas to gust out noticeably as the finger is removed. (This action, which is very slight, will not cause the water in the saturator to be siphoned into the system.) The reason for setting a low flow rate is to establish a gas pressure which is nearly atmospheric. When the lowest perceptible flow has been obtained, it is assumed to be atmospheric; although this is not exactly true (since atmospheric pressure is static), the calculation of water content will not be affected. Figure 8-6 illustrates the flow pattern through valves B and D of the system with valves A and C closed.

14. Engage ends of the cable in the electrical indicator socket and in the detector.

15. Turn the main switch on. The meter will probably read off scale, either below 0 or above 50. The electrical indicator is designed so that no combination or adjustment of the meter control and the resistance of the detector will burn out the meter. Rotate the meter control knob until the meter reads on scale. Continue the adjustment until the needle is pointing to the midscale position, 25. (The reading of 25, or any other scale reading obtained while testing gas under pressure, is an indication or measurement of resistance. Therefore the value indicated by the meter is only relative to the problem. Further calculation is necessary before the water vapor content, in milligrams per liter, can be determined.)

16. Check the sensitivity of the film by blocking the gas outlet, thus increasing the pressure in the detector block. Under these conditions, the meter reading should advance immediately above 50. When the finger (blocking the outlet) is removed, the meter should return to approximately 25. It may not return exactly to 25, since the meter reading is expected to drift slowly downscale. Occasionally a little condensed water will come through valve B, producing momentary increases in the meter reading. These brief deflections should be disregarded.

17. Readjust meter to a convenient ON SCALE position. For purposes of illustration, 25 or the MIDSCALE position, has been chosen as the example. This reading is known as the BALANCE POINT. ONCE THE BALANCE POINT HAS BEEN CHOSEN, DO NOT MOVE THE METER ADJUSTING CONTROL UNTIL THE TEST IS COMPLETED. Turn off the main switch.

18. Close valve B, then valve D. Closing these valves in the reverse order of opening them prevents the saturated gas from building up pressure in the detector block and disturbing the balance point.

19. To use the calculator illustrated in figure 8-7, apply the following example:

a. Using the large tab on the calculator, set the saturated gas pressure used (700 p.s.i.) opposite the present indicated temperature;

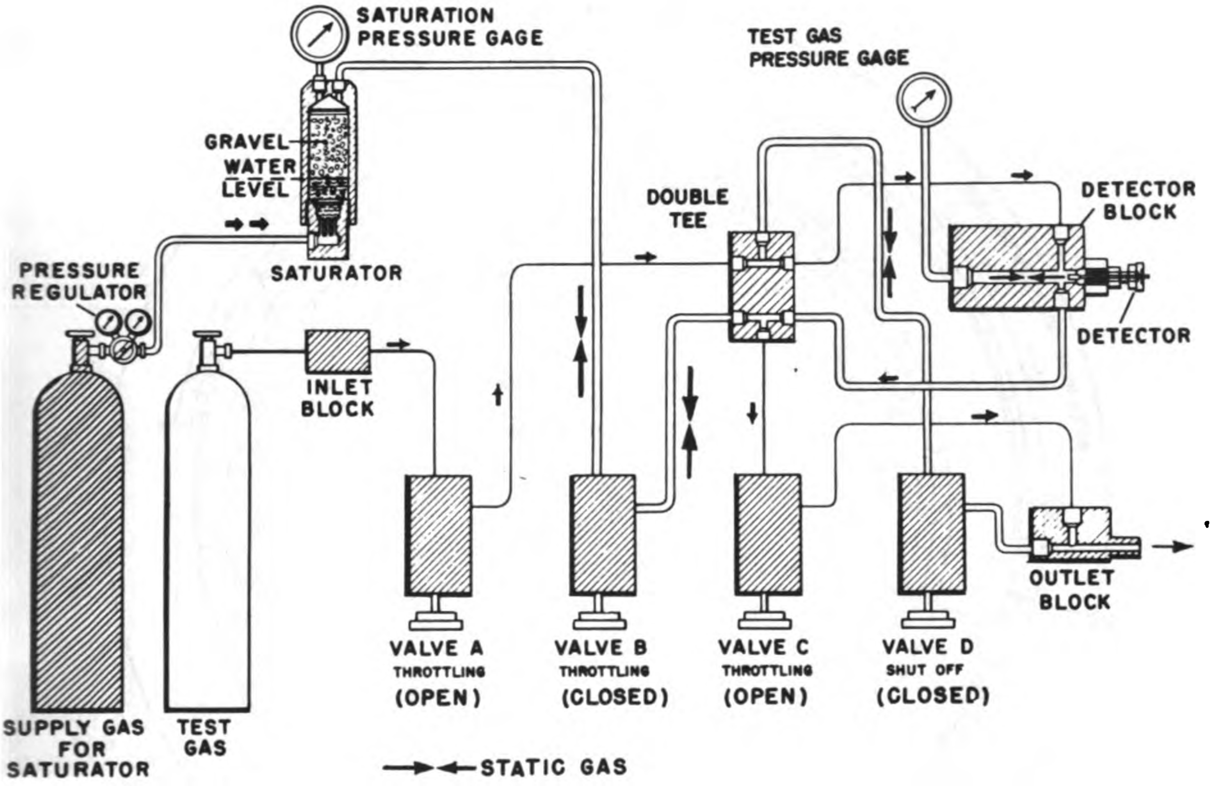


Figure 8-6.—Flow pattern of saturated gas with valves B and D open and valves A and C closed.

r example, 80° F. When these figures have en matched, hold the tab in position to prevent ippage in the operation to follow.

b. Set the hairline of the index (narrow ojecting tab) on 0.02. (Outer scale represents ater content.) The figure 0.02 is familiar all Parachute Riggers, and they should know mediately that the value represented is the aximum allowable water vapor content in iator's breathing oxygen.

c. Trace the hairline; and where it tersects on the test gas scale, record the st gas pressure to be used. In this example, reads 450 p.s.i.

Soon, in describing the operating steps inlved in testing the test gas, the relationship the figures given in this example to the meter ading will be understood.

20. Open the valve on the test gas cylinder.

21. Open valve C completely. This controls e gas flow through the outlet block.

22. Open valve A slightly. The gas should w be flowing from the outlet block. Turn on the microammeter switch without moving the ADJUST METER knob. The meter will probably read below zero on the scale. Close valve C slowly. This action will cause an increase of pressure in the detector block. The test gas gage will show this rise in pressure. Figure 8-8 illustrates the flow pattern through valves A and C of the system with valves B and D closed.

23. Continue closing valve C until the test gas pressure previously determined on the calculator has been reached. In the example, this pressure reading was established to be 450 p.s.i.

24. Observe the meter reading in relation to the previously set balance point, 25. If the indicating needle of the meter has not left 0 or has not reached the balance point of 25, the gas is within the specified maximum water vapor limit. If the indicating needle of the meter is on the balance point exactly, the water vapor content of the gas is 0.02 milligrams per liter. If the microammeter needle exceeds or passes

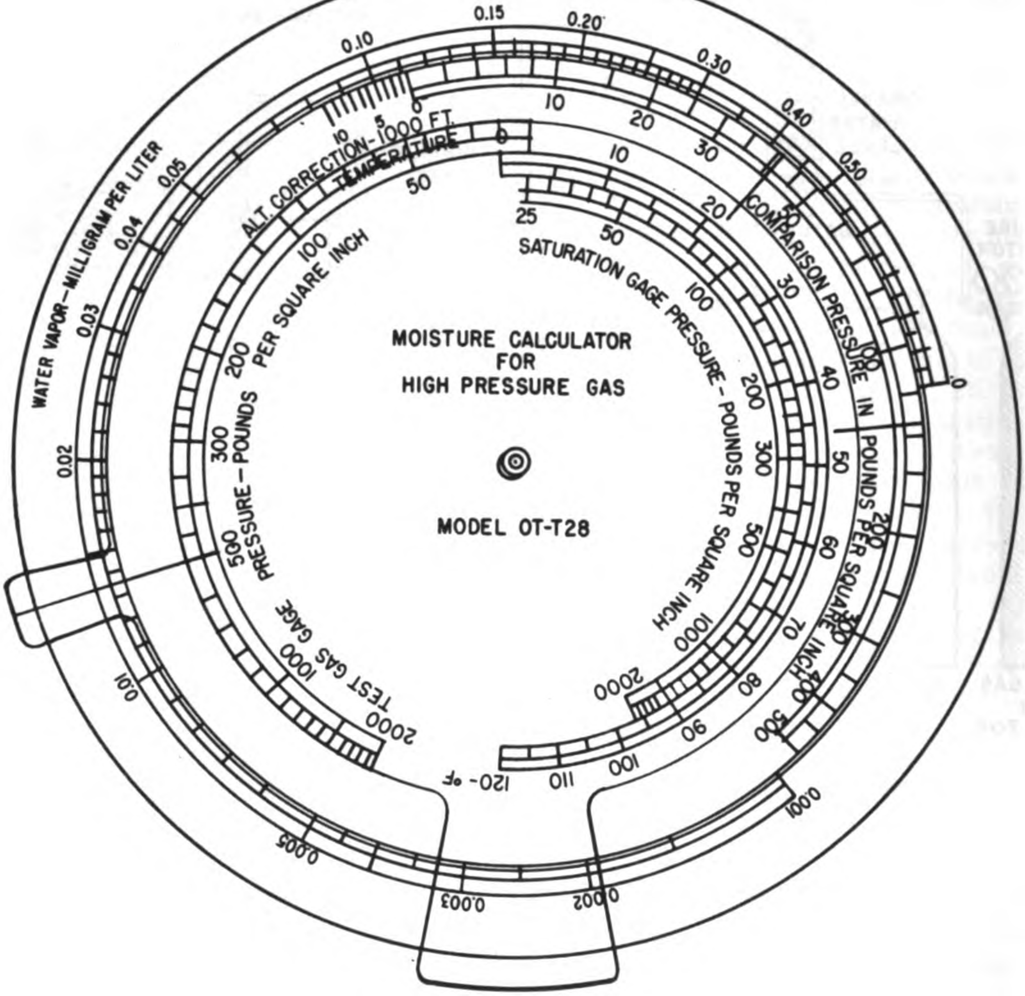


Figure 8-7.—Use of calculator when measurements are made at sea level.

the established balance point before the 450 p.s.i. is reached on the test gas pressure gage, the test gas contains excessive moisture. In this case, repeat test steps to assure accuracy of the results. In most instances, the reading will be to the left of the balance point (refer to gages and meter in fig. 8-1), or the needle will not move from the 0 position. It then follows that any reading between 0 and the balance point indicates the gas contains less than 0.02 milligram of water vapor per liter.

As a general practice, it is not necessary for the Parachute Rigger to know the exact water vapor content—all he needs to know is whether the test gas is within the maximum allowable limit. However, for an accurate accounting record, one which can be audited logically, figures are necessary. A neat and accurat record can provide valuable information an should be available. For a similar method, bu one that leads to the exact calculation of the wate content of the gas, refer to the *Operation an Service Instruction Manual for the Water Vapor Indicator*, NA 17-15BC-501.

SHUTTING DOWN PROCEDURE.—The procedure used to secure the instrument follows:

1. Turn off the main switch.
2. Close the cylinder valves on the saturatio and test gas supplies.
3. Loosen the test gas line at the inl block slowly until the pressure trapped in th

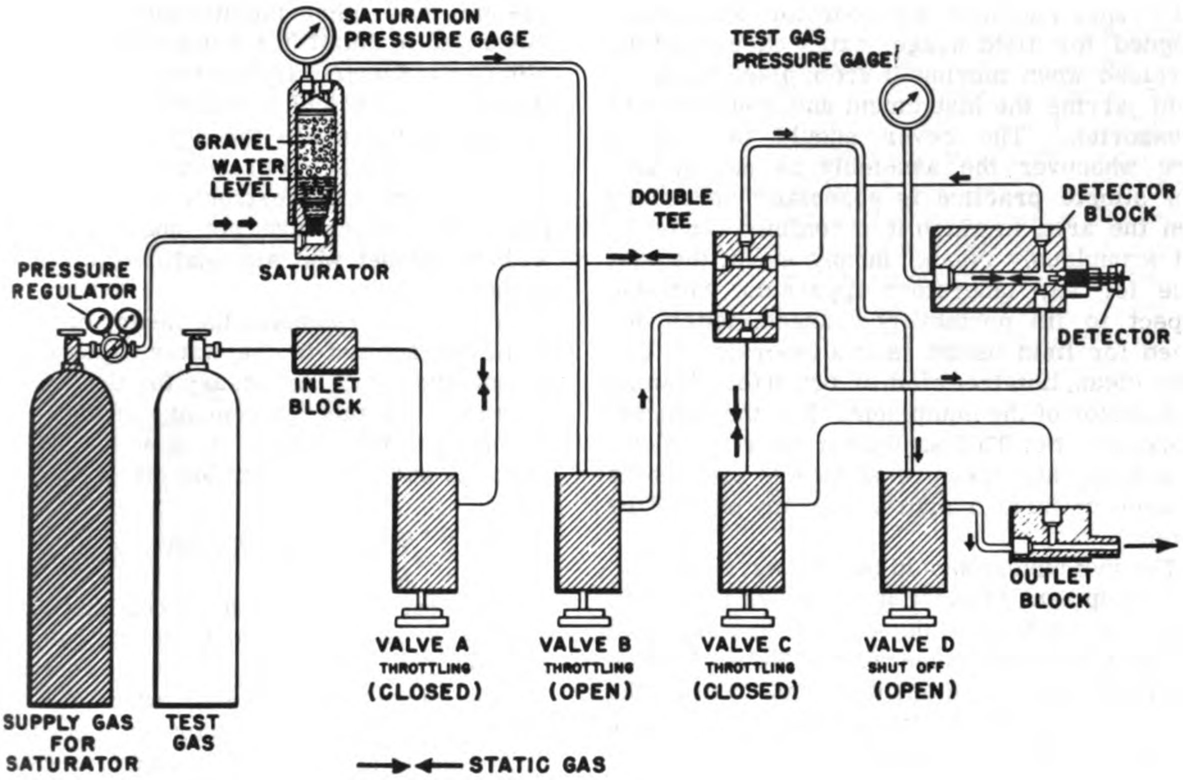


Figure 8-8.—Flow pattern of test gas with valves A and C open and valves B and D closed.

e is released; then break (disconnect) the
nnection.

4. Loosen the nut connecting the saturation
essure gage to the top of the saturator.
is will allow gas to escape from the satu-
tor and connecting components until the pres-
re is reduced to zero. (The zero reference
plies to an ordinary pressure gage indication,
ice 14.7 p.s.i. is the atmospheric pressure at
a level.) Break the connection at the top of
e saturator. Disconnecting the fitting will
pose the threaded hole, and thereby aid the
aining process later on.

5. Turn the adjusting screw of the pressure
ducer counterclockwise until it spins freely.

6. Disconnect the saturation gas line from
e pressure reducer. Hold the end of the line
low the saturator and the distilled water will
ain out the saturator. After the water is
ained, replace the top connection which aided
e process (connection between the top of the
turator and the pressure gage).

7. Remove the saturation gas line from the bottom of the saturator.

8. Disconnect the electrical cable between the meter and the detector. Remove the detector and clean the tip with cotton soaked in distilled water, then dry it thoroughly. Store the detector in the vial supplied for its protection. If the detector is dropped, its internal insulation will be damaged, rendering it useless.

9. Close all valves located in the blocks. Stow accessories in the rear of the instrument and replace the cover, tightening it in place.

MAINTENANCE.—Preventive maintenance would probably be a more appropriate term for the heading of this section. Preventive maintenance procedures are directed to minimizing breakdowns of equipment. This is accomplished by scheduling periodic inspections and applying the necessary corrective action before the trouble begins.

The most universal application of preventive maintenance involves a relatively simple procedure—keeping the equipment clean. Since the water vapor indicator is a laboratory instrument designed for field usage, extra care must be exercised when moving it from place to place. Avoid jarring the instrument and scattering its accessories. The cover should be kept in place whenever the assembly is not in use. This simple practice is especially necessary when the area in which it is confined cannot be kept scupulously clean. In any event, the best place for any laboratory apparatus, with due respect to its portability characteristics designed for field usage, is in a laboratory. Use a dry, clean, lint-free cloth or brush for cleaning the exterior of the equipment. For the removal of rust, use No. 0000 sandpaper or crocus cloth. When doing this, take precautions to prevent the entrance of foreign matter into any part of the system.

The instrument should be kept warm and dry. Cold equipment brought into a warm room will sweat and continue to do so until the equipment warms up to room temperature. This condition also arises when equipment warms up during the day after exposure to the atmosphere during a cold night. If the equipment is observed to sweat, valves (less knobs), detector block, gas inlet, gas outlet, and all connecting lines will have to be removed for drying. To dry, bake in an oven for several hours at 225° F. This procedure will remove the water from inside the flow assembly. Before the system (fig. 8-8) is placed in an oven, disconnect the tubes from the blocks and other components; also disassemble the valves. Since the valve knobs would be damaged by oven heat, do not bake them with the rest of the components.

At any time during the operation of the equipment, or under other conditions, water enters the detector block and connections, the test gas passing through the system would be nearly saturated. This would make a dry reading impossible. During operation, careless use of gas pressure and flows can cause the water in the saturator to be blown into the system. Since it takes hours to dry the components (fig. 8-8), a logical practice of maintaining a spare set of these items seems feasible. While the wet parts are being dried, the second set could be put into operation, thereby saving the valuable time that would otherwise be lost in the baking process.

Information relative to troubleshooting, grinding the detector tip, care of the electrical system, and other maintenance problems are discussed in detail in the manufacturer's *Operation and Service Instruction Manual for the Water Vapor Indicator* (NA 17-15BC-501). This manual accompanies the equipment or can be ordered through publication channels. Before operation, read the instructions. Discuss those principles which are not understood clearly with personnel who are qualified to render assistance.

While understanding the theory of measurement (as applied to the water vapor indicator) is not absolutely necessary for the successful operation of the instrument, anyone qualified to operate and service it should make an attempt to study the principles involved.

THE OXYGEN ANALYZER

How can we be certain breathing oxygen, a colorless, odorless, and tasteless gas, is pure (almost 100 percent pure)? Can we trust our senses of taste and smell when the gas we breathe has a peculiar odor or leaves an undetermined taste in the mouth? Even the cleanest aircraft oxygen systems affect the odorless characteristic of the gas it conveys. Airmen breathing through a system become conscious of the odor associated with that system. This odor (a mixture and blend of odors coming from rubber, copper, aluminum, brass, etc.), when only slightly noticeable, is no cause for alarm. One reason for this is that the men breathing oxygen feel safe in doing so. They take the purity of the gas for granted. Do not misunderstand the meaning of the word purity however. Purity can mean pure poison. When technicians in a laboratory seek the purity of a gas, they are searching for the percentage or partial pressure of a particular element in relation to others that may also be present in the given volume of gas under study.

Beckman Model E-2

This instrument is designed to provide an accurate and easily usable means of determining the partial pressure and corresponding percentage of oxygen in gaseous mixtures, or the purity of oxygen employed. To determine the partial pressure, which is a relative indication of the percentage of the gas, a comparison between a gas of known purity (reference gas) and ne of unknown purity (sample or test gas) ust be made. The Model E-2 was designed pecifically to analyze mixtures containing a igh percentage of oxygen. After proper standrdization and under the recommended test pecifications involving temperature, flow, presure, and moisture content, the analyzer is ccurate to within ±0.5 percent of the full scale ange. (See fig. 8-9.)

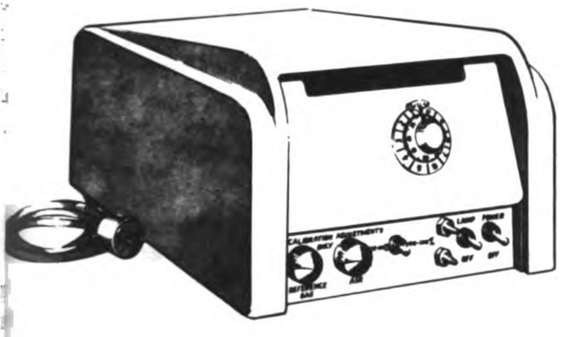


Figure 8-9.—Beckman Model E-2.

PRINCIPLES OF OPERATION.—The Beck- an analyzer determines the oxygen partial essure of a gas sample in the analysis system agnet plate assembly) of the instrument by easuring the magnetic susceptibility of the gas ith a magnetic torsion balance. Accurate ygen analyses can be made of mixtures con- ining practically any of the other gases, since ygen is strongly paramagnetic in nature ttracted into a magnetic field). A magnetic eld is simply a space or area between the wo poles of a magnet or set of magnets. When n element is paramagnetic, it is capable of a reater magnetization than a vacuum. This oes not reveal much, but in comparison to omething ferromagnetic (such as iron and ickel which is magnetic in a high degree), ygen is not attracted in a strong degree. owever, this does not prevent oxygen from eing strongly paramagnetic in its own type ttraction. For a complete understanding of is subject, a physics text should be udied.

No solutions or chemicals are used and the ample gas is unchanged in passing through the alyzer. The magnetic balance (torsion alance) consists of a mirror attached to a umbbell-shaped test body which is supported y a quartz fiber. The test body is subjected a magnetic rotational force and assumes a position dependent on the magnetic susceptibility of the test body and the properties of the gas. In addition, the overall physical design of the instrument is another factor considered. To attempt a lengthy discussion of the physical principles upon which the functioning of basic elements of the analyzer operate would exceed the purpose of a training course. In summary, by introducing gas, containing oxygen, into the instrument under a controlled rate of flow, the magnetic susceptibility present is changed by the unknown gas. Hence, the rotation of the test body assumes a new value.

The greater the percentage of oxygen in the gas (normally a Parachute Rigger is interested only in testing aviator's breathing oxygen for purity), the less will be the disturbance in the magnetic field. This is true because the instrument is balanced with nearly pure oxygen when it is prepared for testing. Furthermore, by setting a dial to read this unbalance, the comparative purity of the gas can be determined in a percentage value.

OPERATION.—The operation steps follow:

1. Turning on the power switch also illuminates a small neon pilot light which is visible on the right-hand corner of the screen. Thermoswitches automatically control the heating circuit of the instruments, and maintain the analyzer cell between 130°-140° F. The pilot light is off when the test cell has been brought up to the operating temperature. The minimum warming-up period required prior to operation is 30 minutes; however, for more accurate readings, a longer total period of 2 hours is recommended.
2. Set the range switch (located on front panel) in the 90-100 percent position.
3. Set the graduated dial (duodial 10 to 1 ratio) to the known purity value of the gas to be used as a reference. Commercial high-purity medical oxygen which has already been tested and certified should be used for this purpose. Oxygen of this quality is normally 99.8 to 99.9 percent pure.
4. Pass the reference gas of known purity through the flowrater at the side of the instrument. Then, pass it through the system by engaging a hose between the outlet of the flowrater and any one of the hose nipples on the front panel. The gas must be passed through the instrument at a controlled, fairly constant rate. This is accomplished by adjusting the

valve on the flowrater until the internal float is between 50-250 cc./min. (cubic centimeters per minute) in the tube. To protect the analyzer and the flowrater from damage, a very low rate of flow from the supply source must be used. Purging the instrument for two minutes (the minimum requirement) with the reference gas establishes a high-purity condition in the test cell. (This calibration fixes the scale after the gas has been passing for 2 minutes and the potentiometers are adjusted to center the light beam on the scale.)

5. Turn on the test lamp. The life of this lamp is a short 15 hours; therefore, use it only when necessary to make readings. Next, adjust the REFERENCE GAS knob (located on the lower left side of the front panel) until the light beam is centered on the engraved line in the middle of the scale. Turn off the test lamp, also called the analyzer lamp (PR-12).

6. Set the range switch to the 20-100 percent position, and the duodial to 90.116. This setting corresponds to the 20.93 percent oxygen content of the dry air. Connect the tube from the rubber bulb on the drying tube to the nipple on the analyzer panel. Purge the analyzer completely with dry air by alternately squeezing and releasing the bulb for 2 minutes at a flow of 50-250 cc./min. When the blue indicating chemical in the drying cell of the bulb turns pink (after repeated use), replace the drying compound (silica gel) and the indicating chemical with a fresh supply. Turn on the test lamp, adjust the AIR knob until the light beam is centered on the engraved line in the middle of the scale. Turn off the test lamp. Repeat the procedure for the reference gas adjustment as a recheck of the upper scale limit calibration. Only a slight readjustment of the knob marked REFERENCE GAS should be necessary.

7. After the analyzer has been properly calibrated, it is ready to be used for oxygen analysis. The range switch should now be in the 90-100 percent position, since the reference gas procedure has been repeated. The sample gas is passed through the instrument in a continuous flow at the rate of 50-250 cc./min. for a minimum of 60 seconds, observing the rate of flow carefully. Turn on the test lamp. Rotate the duodial until the light beam centers on the reference point. Turn off the lamp, and read the duodial. If the reading is below 99.50 percent, the oxygen is unfit for use in aircraft.

Whenever the power has been turned and the instrument has had a chance to cool must be recalibrated before reuse. Fig 8-10 is a diagrammatic view of the gas sampl system.

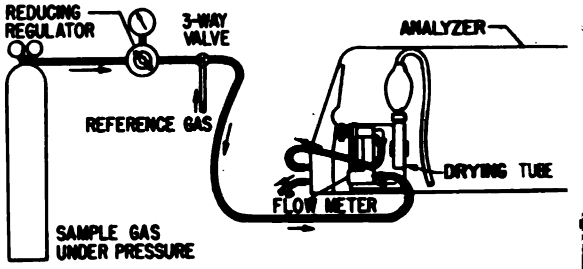


Figure 8-10.—Gas sampling system.

NOTE: The arrangement fr the instrument side of the 3- valve to the source of supply be modified as seen fit. diagram is used primarily convey an idea—not an inflex physical layout.

It is difficult to make fine adjustments an ordinary pressure reading regulator. view of this and the corresponding necess for the application of very low flow rates the sampling system, a special type regula should be used. For this purpose, investig the smooth operating medical types that be adjusted with fingertip ease and accura In selecting one of these expensive un determine the limit of its capacity, keepin mind its adaptability in relation to its use the gas sampling system.

MAINTENANCE.—Thorough inspections conducted at specified intervals to determ the condition and serviceability of the analyz Preventive maintenance procedures includ cleaning, tightening, calibration, and test are performed at the specified intervals calendar or operating times. A perman record of inspections, calibrations, and overh of the instrument should be kept. Natura only qualified personnel should conduct procedures.

Inspections and maintenance required da are those to be performed prior to use of analyzer during any day of operation. Inspect times indicated in hours are the approxim instrument operating times between inspectio hese times are expected to vary with oper- ions.

Clean the lens and windows of the optical ystem with lens tissue; moisten with water necessary. Clean the parts of the analyzer hassis with an approved cleaning solvent. se the solvent sparingly and apply with a ean lint-free cloth or soft brush. Dry parts oroughly. To remove dust from inaccessible aces, use dry compressed air at a maximum of 30 p.s.i. pressure. There are no lubrication problems.

General inspection and maintenance procedures are outlined in table 8-1.

Information relative to balancing portions of the analyzer circuits, barometric and moisture corrections, mathematical formulas involving the use of the duodial, troubleshooting, and other subjects can be found in *Operation and Service Instruction Manual for the Oxygen Analyzer*, NA 17-15BC-502.

Table 8-1.—Inspection and maintenance procedures.

Procedure	Time
heck operation of analyzer lamp	Daily.
neck operation of pilot light	Daily.
aeck movement of duodial and calibration setting knobs	Daily.
lean exterior of front panel window	Daily.
neck condition of drying agent in drying tube; replace if pink	Daily.
neck operation of switches	Daily.
ean lens and windows of optical system with lens tissue	Weekly.
ean interior of analyzer	Monthly.
neck all wiring connections at terminal strips for tightness of terminal screws	Monthly.
spect soldered wire connections for looseness	Monthly.
neck tightness of all attaching screws, bolts, etc.	Monthly.
spect condition of rubber shock mounts	Monthly.
spect all parts of analyzer for evidence of corrosion	Monthly.
neck tightness of all tubes in sockets	Monthly.
emove, test, and replace as required, all tubes in rectifier assembly	100 hours.
sert test thermometer through hole in right rear corner of insulated suspension unit ousing to check temperature of suspension housing	100 hours.
neck transformer for excessive heating	100 hours.
emove insulated suspension unit housing and check security of wire connections and ample inlet tubes	200 hours.

HALIDE DETECTION

While knowledge of the percentage of oxygen a volume of gas is a good indication of its ity, it is not entirely reliable. Oxygen itself never be anything else but oxygen, and as h it is pure; however, it can become con- inated. Unfortunately, this contamination not detectable through the use of the oxygen lyzer. Since this is true, some device other n the analyzer which indicates the percentage oxygen in a gaseous mixture must be used to ect the presence of halides.

A halide is a binary compound containing a ogen (chlorine, bromine, iodine, or fluorine). Binary means that chemically it is composed of two elements, of an element and a radical that acts as an element, or of two radicals. The halide of primary interest to a Parachute Rigger is a chloride.

Contamination takes place when oxygen comes in contact with chlorinated hydrocarbons. The practice of using carbon tetrachloride to clean parts of a system will later contaminate oxygen gas passing through it. The fact that carbon tetrachloride dries very rapidly and seemingly vanishes from the scene is not to be trusted. The fluid residue and gas fumes created in cleaning permeate the surfaces of components; therefore, it is an ineffectual gesture to attempt wiping it away with a cloth. One must be extremely careful not to use anything but approved solvents or cleaning agents around oxygen equipment. The contamination of oxygen is dangerous—from its explosive supporting nature to its purity requirements for human consumption.

Chlorinated Hydrocarbon Contamination

Aviator's breathing oxygen storage cylinders, regardless of source, and aircraft oxygen cylinders are tested for chlorinated hydrocarbon contamination prior to their release for breathing purposes in aircraft. After a satisfactory completion of the test, a distinguishing tag or decal is applied to each cylinder tested, giving the date of the test, place, name of the individual conducting it, and a statement that the cylinder tested does not contain any chlorinated hydrocarbons as evidenced by no change in the color of the testing flame.

This test is performed with a halide detector, one type of which is illustrated in figure 8-11. Another type, designed to burn methyl alcohol and resembling the appearance of a flashlight, may also be used.

The normal uncontaminated flame color of the halide detector which uses methyl alcohol is colorless or possibly a very faint blue. The presence of a very slight trace of chlorinated hydrocarbon impurities in the oxygen causes this flame color to become pale green, and as the proportion of impurities increases in the oxygen a bluish-green colored flame results.

The normal uncontaminated flame color of the halide detector which uses acetylene is blue. The presence of a very slight trace of chlorinated hydrocarbon impurities in the oxygen causes the color of the flame to become pale green; and as the proportion of impurities increases, the flame becomes a more intense green. A large proportion of such impurities in the oxygen results in an intense violet color.

Any chlorinated hydrocarbon contamination, as evidenced by the color of the flame of the halide detectors, is cause for rejection of oxygen cylinders containing this contaminated oxygen. CONTAMINATED OXYGEN MUST NOT BE USED. Rejected cylinders are appropriately tagged and returned to supply through normal channels for overhaul prior to their being recharged and retested, submitting a report t BuWeps regarding circumstances of test.

A General Electric Company Type H Lea Detector Tester may be used in lieu of the halid detectors. However, the halide detectors ar preferred. Each oxygen cylinder that successfully passes the General Electric Leak Detecto Tester test must be tagged. This tag should giv the identity of the activity performing the tes the date of the test, and a statement that th contents of the tested cylinders do not contai chlorinated hydrocarbons in excess of fift parts per million. Report all instances c chlorinated hydrocarbon contamination of oxyge cylinders to the Bureau of Naval Weapons

Untagged aircraft oxygen cylinders installe in aircraft and any untagged aircraft oxyge cylinders received from supply department must be tested and tagged. Repetition of thi test on previously tested and tagged aircraf oxygen cylinders is not required in the fiel provided recharging is always conducted fron tested and tagged aviator's breathing oxyger storage cylinders.

Test tags are not removed from aircraf oxygen cylinders and aviator's breathing oxyge storage cylinders until the need for retestin arises, at which time the old tag is replace with an appropriate new one. This new ta should give all the necessary identifying information relative to the place, date, individua making the test, and the statement that th particular cylinder does not contain chlorinated hydrocarbons as evidenced by the typ of instrument used. An example is as follows

Type of test. . . . .Chlorinated hydrocarbon
Place . . . . .NAS, Memphis, Tenn., O
erations Department
Date. . . . . .18 July 1961
Tested by . . . . . .Jess W. Carr, PRC
Result. . . . . .This cylinder was hali
tested using an approv
acetylene type tester on t
date listed above. No tra
of chlorinated hydrocarb
could be identified, as t
blue flame characteristic
this testing device did n
change color.

All cylinders are retested when the te tag is lost or permanently removed for a

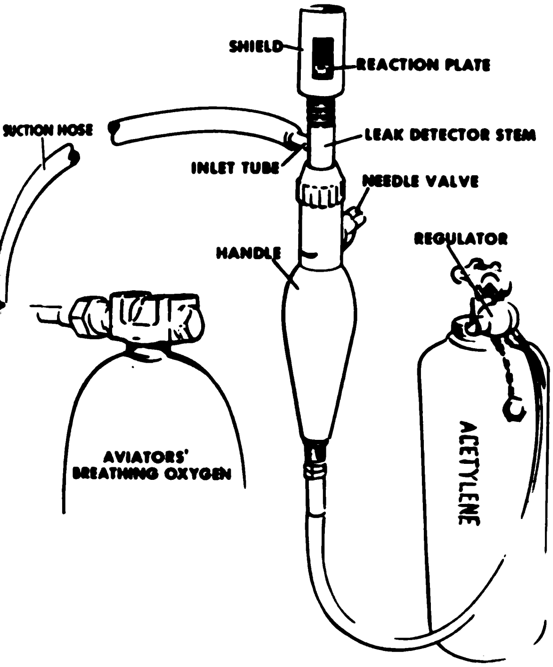


Figure 8-11.—Prest-O-Lite Halide Leak Detector, acetylene and test gas.

reason. All oxygen cylinders are retested when contamination of the oxygen system occurs or is suspected.

All aircraft oxygen cylinders are retested when the aircraft in which they are installed are overhauled.

Inspect all aircraft oxygen cylinders during AIRCRAFT ACCEPTANCE CHECKS for compliance with the last statement.

Water vapor tests and other purity tests may be conducted by experienced Parachute Riggers after they have attended and successfully graduated from the appropriate school.

CHAPTER 9

OXYGEN REGULATORS

PARACHUTE RIGGER'S RESPONSIBILITIES

Oxygen regulator maintenance was formerly the entire responsibility of the Parachute Rigger. However, under the current rating structure, personnel of the AME rating are responsible for checking regulators installed in aircraft and for their removal and installation, while the Parachute Rigger is responsible for shop testing and maintenance. Malfunctioning regulators are therefore removed from the aircraft by the AME and delivered to the regulator repair shop, where the PR performs the necessary shop maintenance. The AME then reinstalls the regulator in the aircraft.

Although it is not always necessary to completely disassemble a regulator to make the necessary repairs, this chapter covers disassembly and reassembly of one of the various types of regulators now being used by the Navy, and describes the recommended methods of determining and remedying malfunctions. The first section of this chapter discusses some of the problems involved in establishing and organizing a regulator repair shop.

REGULATOR REPAIR SHOP

Space Requirements

Adequate space for the installation of all necessary equipment must be available before undertaking the maintenance of oxygen regulators. Approximately 600 square feet of floor space is the minimum requirement for the establishment of a combined oxygen and carbon dioxide shop. This size shop is suitable for the support of approximately 200 aircraft. More space should be provided where larger numbers of aircraft are serviced, and separate rooms for the various shop functions are also desirable. In addition, a loading ramp for the handling of oxygen storage cylinders should be provided.

Equipment Requirements

The following basic equipment is require
Oxygen recharge equipment, demand oxyg regulator test stand, vacuum pump, oxygen wat vapor indicator, Halide detector, oxygen r charge trailer, carbon dioxide recharge equi ment, and Detecto scale.

In addition to the above listed basic equi ment, the following should be provided:

Oxygen storage cylinder tilt rack, carbo dioxide cylinder tilt rack, 3 workbenches, carbon dioxide detection equipment, rotary storag bin, oxygen cylinder storage bin, machinist's vise, and the necessary handtools. Special tools are listed in the applicable sections of this chapter and the chapter following.

Shop Organization

Once the space and equipment requiremen have been met, it is important to arrange th equipment in order to provide for its efficien use. Any functional organization should be designed to eliminate unnecessary movement an handling of oxygen cylinders. Equipment shoul be so located that supply cylinders may b moved from one apparatus to another in th logical sequence of their tests without interfering in any way with the other functions of th oxygen shop. For example, it is advantageou to have the supply cylinder tilt rack adjacent t the door of the shop. A bench located near th tilt rack for the oxygen water vapor indicato Halide detector, and carbon dioxide detecto allows for vapor and purity tests to be performe on incoming oxygen cylinders without movin them a second time. The cylinders are the moved to the nearby oxygen recharge equipmen This unit should be located so that exhauste cylinders can be removed from the shop easil

It is advisable to separate the carbon dioxid recharge equipment from the oxygen section the shop when practicable. The weight scal cylinder vise, and transfer unit should be mounted on a sturdy workbench; and it is well to provide space at one end of the bench for the carbon dioxide supply cylinder tilt rack. There should also be plenty of ventilation in the vicinity of this section. If possible, the carbon dioxide equipment should be situated near a window in order that cylinder charging may be vented to the outside.

Segregation of all equipment relating to oxygen regulators is highly desirable, either by partitioning the shop or grouping this material in a separate section. This section should also be in a dirt- and dust-free area. The vacuum pump may be located in this area, under the bench supporting the regulator test stand. In addition, a regulator workbench and adjacent storage space should be provided. Personnel working in this segregated area would be undisturbed and would be in a position to use the equipment with maximum effectiveness.

AUTOMATIC POSITIVE PRESSURE AND COMPOSITE DILUTER DEMAND OXYGEN REGULATORS

Automatic Positive Pressure Regulators

The automatic positive pressure diluter demand oxygen regulators, Pioneer-Central Types 867 and 2873, are used in high-altitude flight o supply oxygen under pressure to the user. The regulator illustrated in figure 9-1 is the 867-B1. The only difference between the 2867 nd the 2873 is that the 2873 does not incorporate he inlet and shutoff valve assembly. They utomatically mix air and oxygen at a ratio which depends upon altitude. The mixture is elivered to the user upon inhalation. A presure breathing mask, such as the A-13A, must e used with these regulators. With a tight mask, hese regulators, supplying 100% oxygen, can be sed up to 43,000 feet under normal conditions. ervice ceilings may be exceeded by 2,000 feet or short periods of time in case of emergency. t altitudes above approximately 34,000 feet, ositive pressure is supplied to the user.

Although the 2867-B1 is the most widely sed of this series of regulators, another model esignated as the 2867-A1B is still used in some ircraft. The B1 differs from the A1B in that e B1 has been modified so that the flow indiator vents into the case. This modification allows the flow indicator to continue to operate at pressure breathing altitudes. Accessories Bulletin 18-61 directs that all the composite and pressure breathing regulators will be modified to the B1 configuration at the next scheduled overhaul. For this reason, only the B1 will be discussed.

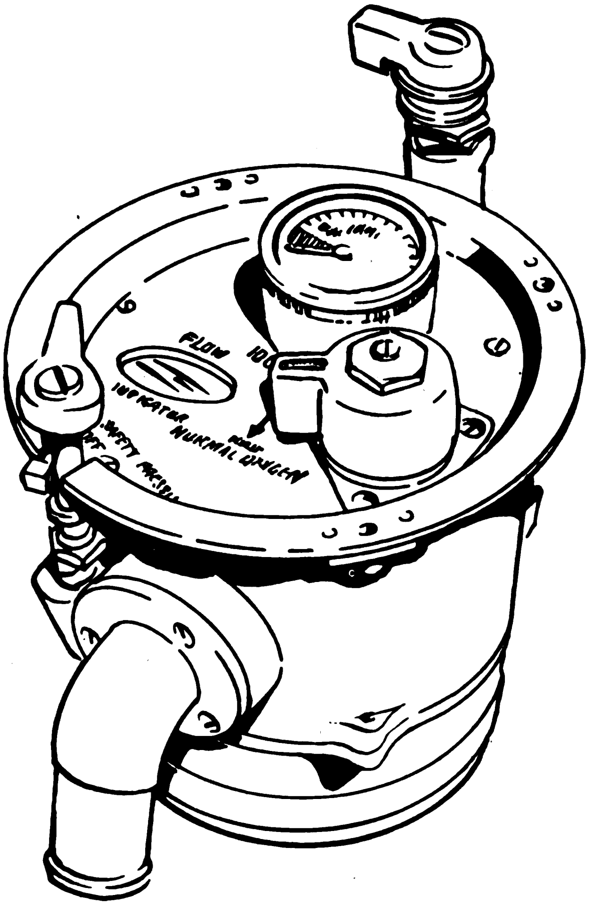


Figure 9-1.—Three-quarter view of automatic positive pressure diluter demand oxygen regulator, Pioneer-Central Type 2867-B1

Composite Regulators

Composite diluter demand regulators, Pioneer-Central Types 2872 and 2874, are also used for high-altitude flight. The only difference between the 2872 and the 2874 is that the 2872 has an inlet and shutoff valve assembly; the 2874 does not. They have a service ceiling of

40,000 feet and are used with the A-13A pressure mask. These regulators do not incorporate a pressure breathing back, otherwise they are identical in appearance to the automatic positive pressure regulators.

Disassembly of Automatic Positive Pressure and Composite Diluter Demand Oxygen Regulators

Since disassembly of all of these regulators is a similar operation, only the step-by-step procedure for disassembling the 2867-B1 regulator is presented in this section.

The following Bendix special tools and test equipment are required:

BENDIX PART NUMBER	NOMENCLATURE
QB70065-1	Wrench, Fixed Spanner
QB70737-5	Wrench, Piloted Spanner
QB70750-9	Wrench, Piloted Spanner
QB71259-1	Adapter, Pressure Gage
QB71260-1	Wrench, Hex Key
QB72025-1	Wrench, Slotted Socket
TQ-12-A	Wrench, Torque (0-150 inch-pounds)
TQ-50-A	Wrench, Torque (0-600 inch-pounds)
508	Gage (0-100 p.s.i.)
609	Key, T-Handle

REMOVAL OF BLINKER TUBE AND PRESSURE TUBE ASSEMBLIES.—The blinker tube assembly is removed first in order to clear the flow tubes on the regulator inlet assembly. Remove the shield. Using a QB72025-1 wrench, take off the blinker tube, being careful not to damage the lead seals on each end of the tube. Remove the inlet tubing shield and the pressure gage tubing at the inlet valve assembly.

DISASSEMBLY OF INLET AND SHUTOFF VALVE ASSEMBLY.—After removing the inlet valve assembly from the regulator case, place the inlet valve body in a vise. Using a 3/4-inch hexagon socket wrench equipped with a 3/8-inch drive and adapting it to the torque wrench TQ-50-A, remove the inlet valve assembly and the O-ring from the inlet body. Carefully remove the retainer and sintered bronze filter assembly, as the inlet valve assembly is spring loaded. Remove the compression spring, valve, seat insert, and O-ring from the inlet housing. Remove the shutoff valve assembly from the inlet valve body.

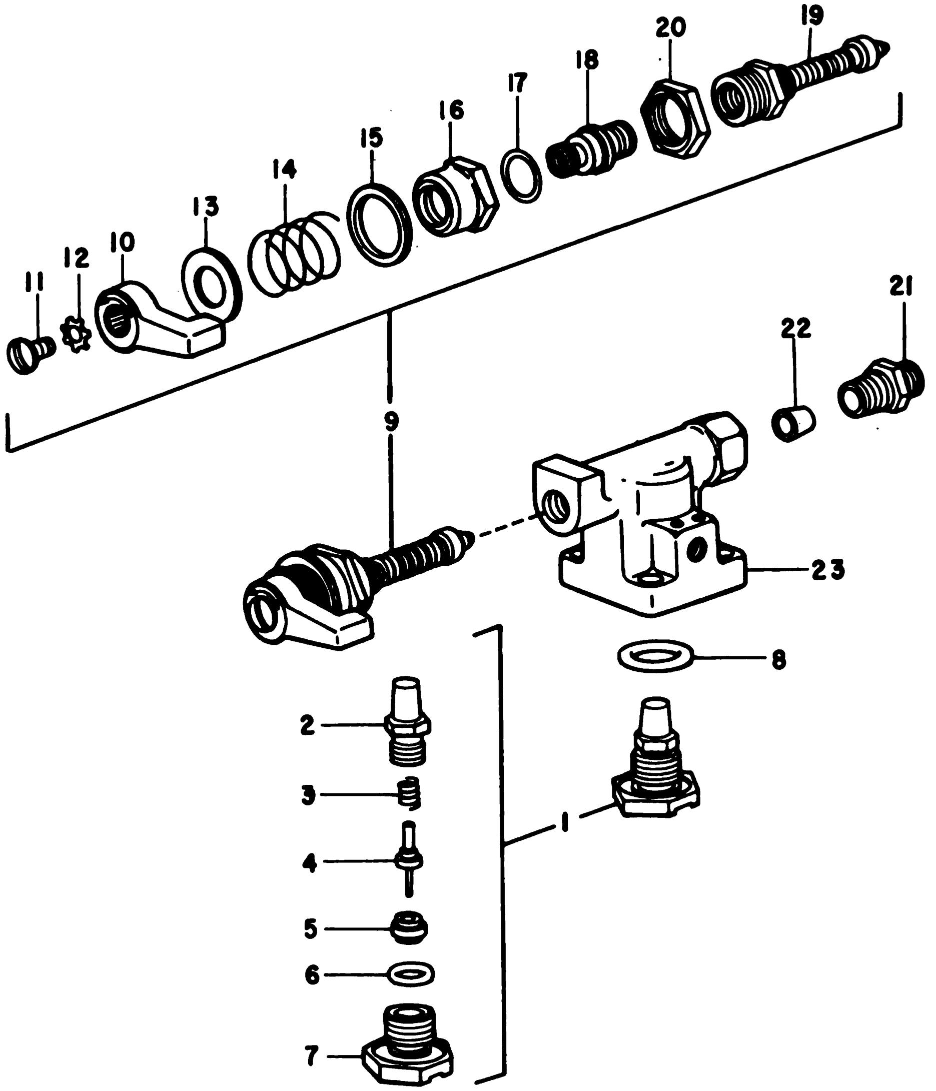
It is not necessary to disassemble the shutoff valve assembly unless repair or replacment is required. If disassembly is required, follow the order indicated by numbers 10 through 20 in figure 9-2. If the shutoff valve is disassembled, determine whether the seat on the valve and guide assembly is lead or nylon. These two different seats on the valve and guide assembly are not interchangeable. Never clean the sintered bronze filters contained in these regulators with any cleaning solvent. They are to be cleaned by reverse flushing with dry, clean, oil-free air.

REMOVAL AND DISASSEMBLY OF ANEROID AND CHECK VALVE ASSEMBLY.—After the air valve knob assembly has been removed from the top of the regulator case, remove the air valve screen and gasket. Using the fixed spanner wrench, unscrew the aneroid and check valve assembly from its chamber in the case. The aneroid and check valve assembly is now disassembled by spreading the prongs and removing the check valve assembly from the aneroid housing. Remove the check valve disc by spreading the prongs, but do not remove the air check valve spring unless replacement is necessary. Remove the aneroid from the aneroid housing case, then remove the screw, throttling place, and spring washer from the aneroid assembly. Remove the nut and the aneroid from the aneroid housing.

REMOVAL AND DISASSEMBLY OF MOUNTING PLATE AND OXYGEN PRESSURE GAGE.—Remove the safety pressure lever from the safety pressure shaft. If this is not done, the mounting plate cannot be removed. Take the six screws out of the mounting plate and lift it off the regular case.

After removal of the mounting plate an oxygen pressure gage, place a piece of maskin tape across the flow indicator dial to hold it i place within the flow indicator chamber. Th oxygen pressure gage should not be separate from the mounting plate unless replacement i necessary. Any damage to the pressure gag or tubing will necessitate replacement of th entire pressure gage assembly.

REMOVAL OF THE OXYGEN FLOW INDI CATOR ASSEMBLY.—Remove the masking tap that temporarily held the flow indicator par within the chamber. As shown in figure 9-



1. Inlet valve assembly.
2. Retainer and sintered bronze filter.
3. Compression spring.
4. Valve.
5. Seat insert.
6. O-ring.
7. Inlet valve housing.
8. O-ring.
9. Shutoff valve assembly.
10. Shutoff valve arm.
11. Screw.
12. External lockwasher.
13. Special washer, large.
14. Spring.
15. Special washer, small.
16. Shutoff valve stem stop.
17. Washer.
18. Actuating screw.
19. Valve and guide assembly.
20. Locknut.
21. Union nipple.
22. Sintered bronze filter.
23. Inlet valve body.

Figure 9-2.—Exploded view of inlet and shutoff valve assembly.

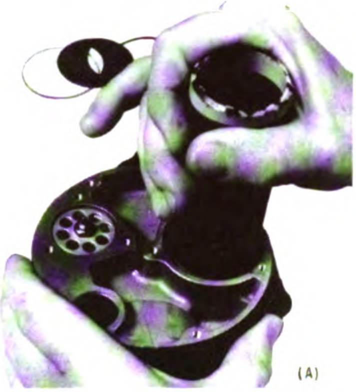


Figure 9-3(A).—Procedure for removal of flow indicator.

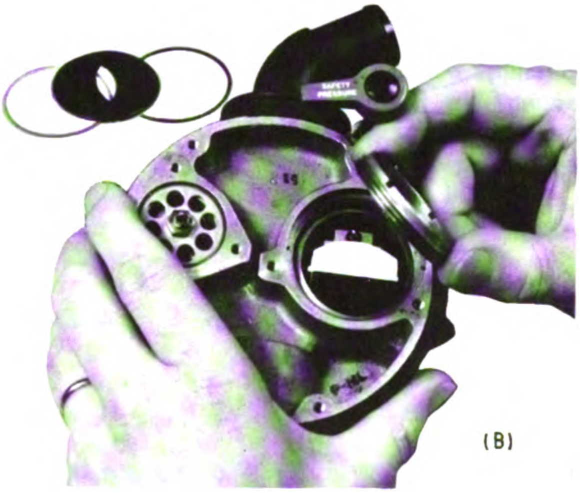


Figure 9-3(B).—Procedure for removal of flow indicator.

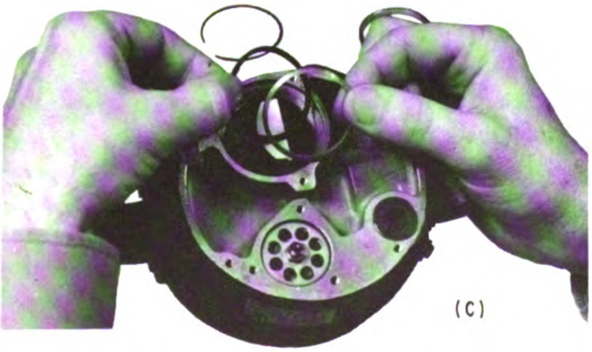


Figure 9-3(C).—Procedure for removal of flow indicator.

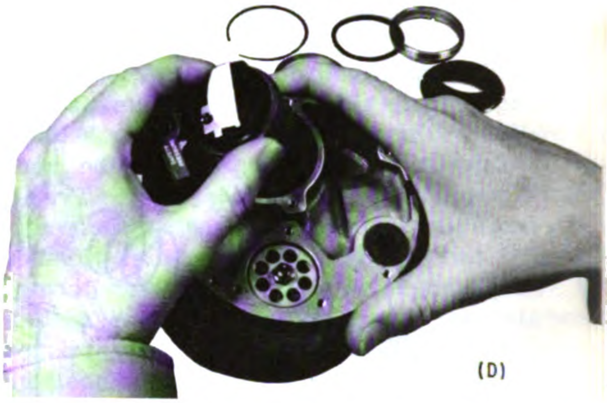


Figure 9-3(D).—Procedure for removal of flow indicator.

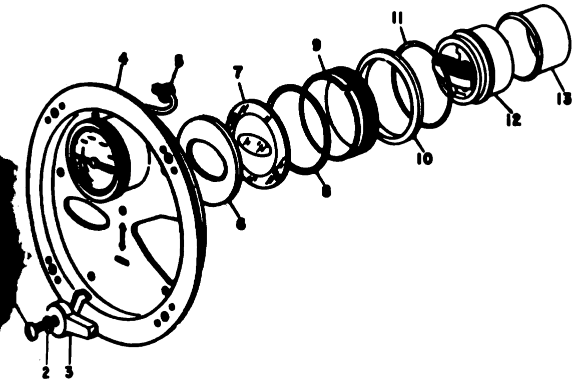
lift off the glass dial and gasket. It is not necessary to separate the gasket from the dial unless replacement of either is required.

Before removing the oxygen flow indicator assembly, observe the position of the black and white portions of the plate in relation to the case. The black portion is located toward the inlet and shutoff valve assembly. The flow indicator assembly must be reassembled in the same position. Using the fixed pin spanner wrench QB70065-1, remove the retaining ring. Extreme care must be taken when using the fixed pin spanner wrench. If it is not positioned correctly, it will damage the lever and plate assembly of the flow indicator assembly.

Holding the blinker in the center of the case, remove the ring. Using tweezers or a jeweler's screwdriver, pry out the packing washer that rests between the frame and the flow indicator case. Lift the case out of the chamber. Figure 9-4 shows an exploded view of the disassembled flow indicator assembly. Disassembly of the oxygen flow indicator is not authorized. If it is damaged in any way, the entire flow indicator assembly must be replaced.

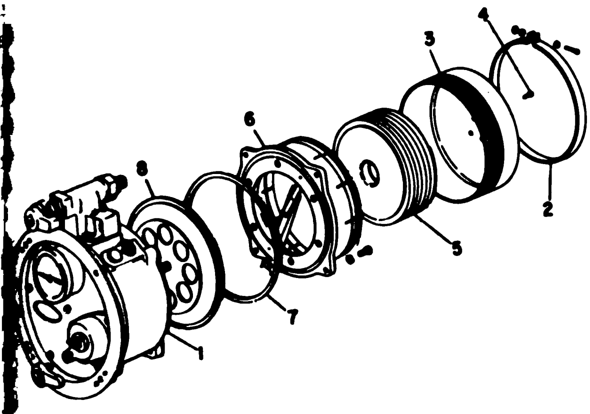
REMOVAL OF REGULATOR BACK ASSEMBLY.—In order to continue the disassembly of the parts mounted on the case, the assemblies attached to the back of the case must be removed first.

Remove the four screws in the pressure breathing housing assembly and lift off the regulator case. (See fig. 9-5.) Lift off the diaphragm gasket, then the diaphragm assembly. Further disassembly of the diaphragm assembly must



1. Screw.
2. Lockwasher.
3. Safety pressure lever.
4. Mounting plate.
5. Oxygen pressure gage tubing.
6. Gasket.
7. Dial glass.
8. O-ring.
9. Retaining ring.
10. Ring.
11. Packing washer.
12. Flow indicator assembly.
13. Piston seal.

Figure 9-4.—Exploded view of mounting plate and flow indicator assembly.



Oxygen regulator stripped assembly.
2. Retaining strap.
3. Pressure breathing aneroid cover.
4. Screw.
5. Pressure breathing aneroid assembly.
6. Pressure breathing housing assembly.
7. Diaphragm gasket.
8. Diaphragm assembly.

Figure 9-5.—Exploded view of diaphragm and pressure breathing back assembly.

not be attempted. Remove the screws and separate the housing from the plate and lever assembly. Loosen the screw and nut at the end of the ratio lever (long bar). This will be calibrated during reassembly. Loosen and remove the pressure breathing button (hex nut). Loosen the setscrew and slide the retaining strap over the aneroid cover. Unscrew the aneroid cover to separate the housing assembly from the aneroid assembly. Take out the three small screws and remove the aneroid from the cover.

REMOVAL AND DISASSEMBLY OF COUNTERWEIGHT LEVER AND BRACKET ASSEMBLY.—Take out the two screws that secure the counterweight and bracket assembly to the case and lift from the regulator case.

DEMAND VALVE ASSEMBLY.—The demand valve is not removed. If damaged in any way, UNDER NO CIRCUMSTANCES will the Parachute Rigger attempt any repairs or replacements on the demand valve assembly. If damaged, or should replacement of any part of the demand valve be necessary, REPLACE THE REGULATOR.

REMOVAL AND DISASSEMBLY OF THE INJECTOR ASSEMBLY.—Remove the outlet and, using the piloted spanner wrench QB70750-9, unscrew the mixing tube. Remove the compression spring and the piston with the O-ring. Remove the injector housing and gasket. The injector nozzle is an integral part of the injector housing.

REMOVAL AND DISASSEMBLY OF PRESSURE REDUCER ASSEMBLY.—Using a 3/8-inch open-end wrench and the T-handle wrench 609, loosen the pressure reducer nut (wrench 609 holds the stem). Take off the nut and two gaskets. Only on the 2867 and newer regulators can the T-handle key wrench be used. These regulators have a hole drilled through the case from the injector chamber for access to the pressure reducer bellows stem. On the older regulators the hex key wrench QB71260-1 must be used to remove the pressure reducer. Reinsert the hex key wrench or T-handle wrench and screw out the pressure reducer bellows. Remove the spring dampener from the pressure reducer bellows and the chamber liner from the pressure reducer chamber. No further disassembly of the pressure reducer is authorized.

Cleaning, Inspection, Reassembly, and Testing

General cleaning is essential after disassembly. For cleaning parts that must be washed, use Freon 113. Dry with clean, dry, oil-free air. Clean, dry, oil-free air is compressed air that has been compressed with a pump lubricated with water vapor. Any parts, such as gaskets, diaphragms, etc., made of rubber are never washed. Under no circumstances should oil or any lubricant be used on the regulator.

Inspect the individual regulator parts for damage, nicks, scratches, burrs, deterioration, and signs of wear. Insure that mating parts, such as the inlet valve pin and seat and the check valve disc and aneroid housing, are smooth and free from scratches or burrs that may cause leakage or malfunction. Inspect the diaphragm and piston seal for holes, tears, and signs of wear. Replace all worn, damaged, or distorted screens, springs, gaskets and screws.

TESTING THE OXYGEN HIGH-PRESSURE GAGE.—Connect the tube and pressure gage assembly to a source of high-pressure oxygen (1,800 p.s.i.) to check the operation of the pressure gage. Check the pressure gage on decreasing pressures at 1,500, 1,000, and 500 p.s.i. It must read correctly within plus or minus 75 p.s.i.

REASSEMBLY OF INLET AND SHUTOFF VALVE ASSEMBLY.—Insert the 0-ring, seat insert, valve, and compression spring in the inlet valve housing in the order shown in figure 9-2. Using a torque wrench TQ-12-A and a 3/8-inch socket, tighten the retainer and filter assembly to a torque of 30 to 40 inch-pounds. Using torque wrench TQ-50-A and a 3/4-inch socket, tighten the inlet valve assembly to 125 to 150 inch-pounds. Use of greater force may turn the head off the seat. Install the sintered bronze filter and the union nipple in the inlet valve body.

Apply a small amount of Dow Corning DC-7 to the outer threads of the valve and guide assembly. Place the locknut on the valve and guide assembly. Apply a small amount of Dow Corning DC-7 to the threads and install the actuating screws in the valve and guide assembly. Install the shutoff valve assembly in the inlet valve body. Slip the shutoff valve arm over the serrations of the actuating screw. Using the shutoff valve arm for leverage, tighten the actuating screw finger tight. After the actuating screw is tight, relocate the shutoff valve arm to the OFF position, as shown in figure 9-6. Open the shutoff valve by turning the shutoff valve arm counterclockwise approximately 200 degrees. Lift off the shutoff valve arm, being careful to leave the actuating screw in the same position. Install the washer in the shutoff valve stem stop. Using two wrenches, tighten the shutoff valve stem stop and the valve and guide assembly lock nut.

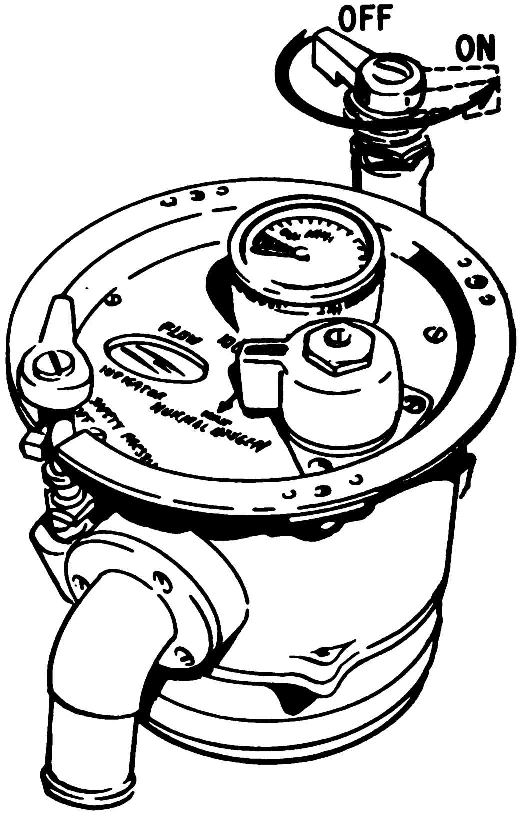


Figure 9-6.—Position of shutoff valve arm.

After the assembly has been tightened, check the rotation of the shutoff valve arm from OFF to ON. There should be approximately a 200-degree inboard rotation. It is important that the rotation be inboard, as the mounting of this regulator in some aircraft will not allow outboard rotation. Install the small special washer, the spring, the large special washer, and the shutoff valve arm to the valve and guide assembly. Secure the shutoff valve arm with the screw and external lockwasher.

TESTING THE INLET AND SHUTOFF VALVE ASSEMBLY.—After the inlet and shutoff valve assembly has been reassembled, the following test must be performed. Apply a small amount of thread lubricant MIL-T-5542B (anti-seize compound) to the pipe threads of the union nipple. Connect the inlet and shutoff valve assembly to a controllable source of oxygen and apply 1,600 to 2,000 p.s.i. through the nipple and dip the assembly into a container of water. There must be no leakage, which would be indicated by bubbles. Turn off the pressure and release the 1,600 to 2,000 p.s.i. in the line. Apply 50 p.s.i. pressure and repeat the test. There must be no leakage.

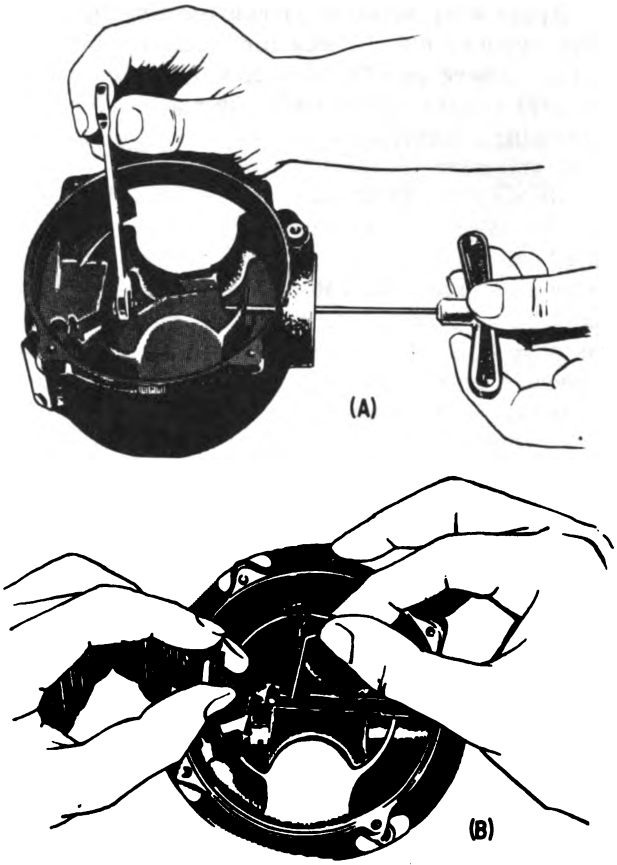
INSTALLING PRESSURE REDUCER ASSEMBLY.—Scribe a mark on the case, aligning the hole in the case that goes to the lower demand valve chamber with one of the holes in the pressure reducer chamber liner. Insert the pressure reducer assembly into the threaded hole in the case.

Using the T-handle key, or appropriate tool as shown in figure 9-7, screw the pressure reducer assembly into the case. When there are enough threads showing on the inside of the case, assemble the two gaskets and start the pressure reducer stem nut. Place the pressure reducer dampener into the slot on the pressure reducer assembly. Carefully insert the widest end of the pressure reducer chamber liner in the case and around the pressure reducer assembly. Be sure that one of the holes in the pressure reducer chamber liner is aligned with the scribe mark on the case. If this is not done, there will be a restricted flow of oxygen to the demand valve chamber.

Hold the pressure reducer nut with an open end wrench as shown in figure 9-7. Turn the pressure reducer assembly with the T-handle key counterclockwise until the top of the bellows is below the top of the case. On a flat, smooth surface, press the pressure reducer chamber liner flush with the case. Be sure the liner is flush with the case and the pressure reducer dampener is properly seated. Tighten the pressure reducer nut.

Install the gasket, and secure the inlet and shutoff valve assembly to the case with four screws.

ADJUSTING THE PRESSURE REDUCER ASSEMBLY.—Close off the high-pressure gage hole in the inlet valve. Attach the pressure gage adapter QB71259-1 to the hole provided in the side of the case on the pressure side of the demand valve chamber. Attach a 0-100 p.s.i. gage to the gage adapter. Connect the regulator union to a controllable source of pressure. Adjust the inlet oxygen pressure to 100 p.s.i. Loosen the pressure reducer stem nut with an open-end wrench. Using the T-handle key, adjust the pressure reducer stem screw until the gage reads between 55 and 65 p.s.i. as shown in figure 9-7.



(A) Adjusting the pressure reducer assembly using T-handle key No. 609 for 2867, 2872, 2873 and 2874 regulators.

(B) Adjusting the pressure reducer assembly using hex key wrench QB-71260-1 for 2862, 2863 and 2864 regulators.

Figure 9-7.—Methods of adjusting the pressure reducer assembly.

The pressure is usually set at an average of 60 p.s.i. If the pressure is below 55 p.s.i. turn the pressure reducer stem screw clockwise with the T-handle key. If the pressure is above 65 p.s.i. turn the pressure reducer stem screw counterclockwise. When the proper adjustment is obtained, lock the pressure reducer stem screw by holding it in place with the T-handle key and tightening the pressure reducer nut with the open-end wrench.

Apply soap solution around the plug and pressure reducer nut. Check for leaks around these parts. There must be no signs of leakage. Make several checks by lifting the demand valve lever assembly. Remove all traces of soap solution from the parts.

DEMAND VALVE AND INLET VALVE LEAK TEST.—With the pressure of 100 p.s.i. still applied to the inlet and shutoff valve assembly, draw a soap film over the injector opening. There must be no leakage, as indicated by expansion of the soap film. If a leak is indicated, observe the pressure on the pressure gage. If the gage shows a steady rise of pressure above the pressure reducer setting, a leaking inlet valve is indicated. Replace the inlet valve assembly.

ADJUSTING THE DEMAND VALVE LEVER.—Use a lever setting gage, if available. With the pressure of 100 p.s.i. still applied to the inlet and shutoff valve assembly, hold the lever setting gage across the back of the regulator case. Position the end of the lever setting gage over the end of the demand valve lever assembly, as shown in figure 9-8. Adjust the setscrew until the demand valve lever assembly just touches the lever setting gage. Turn off the oxygen supply and disconnect the regulator.

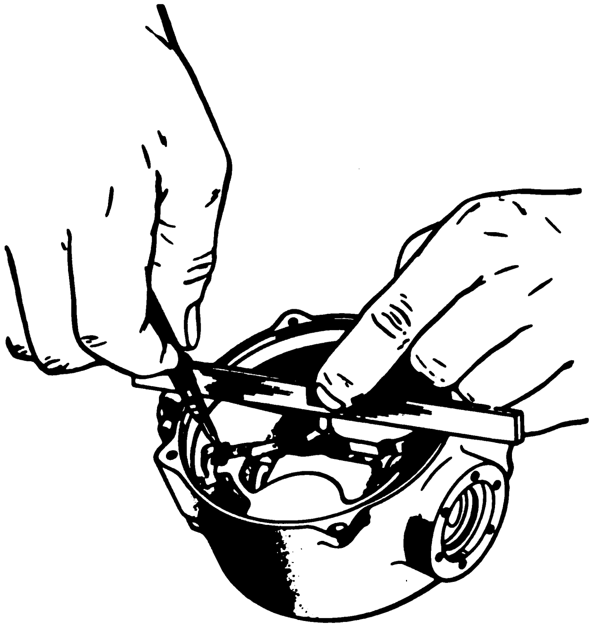


Figure 9-8.—Adjusting the demand valve lever.

In case a lever setting gage is not available, the following method may be used for adjusting the demand valve lever. Hold a straightedge across the back of the regulator case. Position a scale perpendicular to the straightedge over the demand valve lever. Adjust the setscrew in the demand valve lever to measure 33/64 inch from the tip of the demand valve lever to the end of the scale.

INSTALLING THE COUNTERWEIGHT LEVER AND BRACKET ASSEMBLY.—The counterweight lever and bracket assembly is replaced in the reverse order of removal. The counterweight lever must move freely in the recess in the case. The function of the counterweight lever is to insure proper performance of the regulator when the aircraft is involved in violent maneuvers.

REASSEMBLY AND INSTALLING THE INJECTOR ASSEMBLY.—Place the gasket on the injector housing. Place the O-ring on the injector piston. Insert the injector piston with the O-ring, and the compression spring in the injector housing.

Position the injector assembly using the Bendix spanner wrench and the index finger as a guide. (See fig. 9-9.) The slot in the injector must be aligned with the hole in the case that leads to the air valve chamber. If these holes are not aligned, there will be a restricted flow of air into the mixing tube. This condition will be indicated by showing a low air reading during the oxygen ratio test. Lock the injector assembly in this position by screwing in the mixing tube, using the piloted spanner wrench QB70750-9. The mixing tube should be screwed in tightly to insure firm seating of the injector assembly against the gasket.

TESTING THE INJECTOR ASSEMBLY.—Connect the inlet and shutoff valve assembly to a controllable source of oxygen pressure. Apply 150 p.s.i. pressure. Fully depress and release the demand valve lever several times to check the injector for vibration. If the injector assembly howls, the O-ring on the injector piston must be replaced. Secure the oxygen pressure to the regulator and remove the pressure from the regulator by depressing the demand valve lever.

REPLACEMENT OF THE SAFETY PRESSURE MECHANISM.—If the safety pressure shaft was removed, replace the shaft and tighten the setscrew in the case. Install the spring seat and

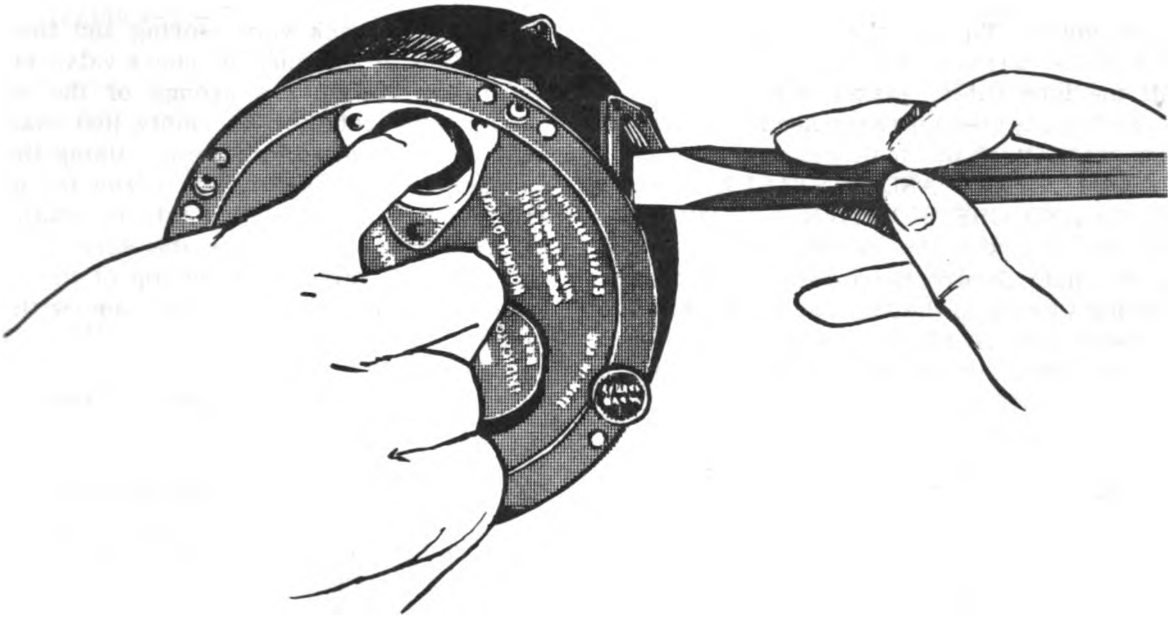


Figure 9-9.—Positioning the injector housing.

e spring on the screw. Install the nut and lock- ut on the screw. Attach these parts to the ottom of the safety pressure shaft assembly. lake certain that the screw is secured in the haft all the way.

REASSEMBLING THE DIAPHRAGM AND OUSING ASSEMBLIES.—Hold the diaphragm ssembly so that the diaphragm plate is facing ownward. Depress the diaphragm screw and ngage it with the U-portion of the counter- eight lever. Install the gasket in the case. ecure the hex nut on the long lever by means f the screw and washer placed between the nut nd the lever. For initial setting of the ratio lamp, the center of the ratio screw will be 7/32 nch from the outboard edge of the slot. Attach e plate and lever assembly to the housing using ix screws. Position the pressure breathing ousing assembly so that the long lever is over e safety pressure opening in the case adjacent the injector assembly. Secure the housing ssembly using the four screws and lockwashers. asten the pressure breathing aneroid as- embly inside the aneroid cover using three crews. Screw the aneroid cover into the housing ssembly all the way, and back off approximately o turns. Do not lock the pressure breathing eroid assembly in place with the strap. The eroid must be calibrated in the test stand efore the strap is tightened.

INSTALLING THE FLOW INDICATOR ASSEMBLY.—Carefully pull the piston seal (fig. 9-4) over the oxygen flow indicator assembly. Place the assembly in the case so that the black portion of the blinker plate moves away from the inlet and shutoff valve assembly when it operates. Position the oxygen flow indicator assembly so that the center line of the blinker plate is aligned evenly across the chamber in the case. Install the packing washer and ring. Using the fixed pin spanner wrench QB70065-1, secure the retaining ring. Install the O-ring, dial glass, and gasket. Temporarily place a piece of masking tape over the dial glass to hold it in the case.

INSTALLING THE MOUNTING PLATE AND OXYGEN PRESSURE GAGE ASSEMBLY.—Install the plug, 0-seal lock, and screw in the case where the 0-100 p.s.i. gage was installed. Using the slotted socket wrench, secure the screw. Place the slot in the mounting plate and oxygen pressure gage assembly under the safety pressure shaft. Remove the masking tape from the dial glass. Carefully align the screw from the pressure gage assembly with the opening in the inlet and shutoff valve assembly. Turn the screw in a few threads, and then secure the mounting plate and pressure gage assembly to the case with the six screws. Tighten the screw on the oxygen pressure gage tube. Install the blinker tube assembly. Tighten the screws using the slotted socket wrench. Install the tube shields. Install the tube filter, gasket, elbow, retainer plate, and safety pressure arm; secure them with the screws. Attach the sealing cap.

REASSEMBLING AND INSTALLING THE ANEROID AND CHECK VALVE ASSEMBLY.— Secure the aneroid to the aneroid housing cover, using the nut. Secure the throttling plate and the spring washer to the aneroid assembly. Be sure there are no nicks or scratches on the throttling plate. Attach the aneroid housing to the aneroid housing cover.

As a preliminary adjustment, turn the aneroid assembly in the aneroid housing until the throttling plate is about 1/8 inch above the seat in the aneroid housing. Lock the aneroid assembly at this adjustment by tightening the nut. This preliminary adjustment is an aid in making the final adjustment which is made during the aneroid closure test. If the results of the test meet the requirements, no further adjustment is necessary.

Attach the spring adapter assembly to the aneroid check valve retainer assembly. On this regulator the spring tension is adjusted by a small setscrew in the spring retainer. Insert the aneroid check valve spring and the check valve disc in the aneroid check valve retainer assembly. Spread the prongs of the aneroid check valve retainer assembly just enough to seat it on the aneroid housing. Using the fixed spanner wrench QB70637-5, screw the aneroid and check valve assembly into its chamber in the regulator case. Place the screen, gasket, and the air valve knob on top of the aneroid assembly and secure to the case with three screws.

Preparing a Performance Sheet

In order to perform the various tests required, a performance worksheet must be prepared. A simple, easy-to-use worksheet is shown in table 9-1. To properly fill in the performance worksheet, percentages must be computed and figures converted from liters per minute (l.p.m.) to inches of water pressure. This is necessary since the regulator test stands measure in inches of water, rather than liters per minute. The procedure for filling in the worksheet will be covered in the sequence of the performance tests listed on the worksheet shown in table 9-1.

Table 9-1.—Performance check worksheet for composite and automatic positive pressure diluter demand regulators.

REGULATOR PERFORMANCE CHECKSHEET

2867, 2872, 2873, 2874 A1, A1B & B1

Date______________ Regulator Type______________ Test Stand No.______________
Operator______________________ Regulator Serial No.______________
1. High-pressure leak______________
2. Overall leak______________
3. Shutoff valve leak______________
4. Outward leak normal______________
Outward leak 100%______________
5. Inward leak______________
6. Flow indicator test______________
7. Flow suction test (100%)______________

Altitude	Inlet pressure	Actual output	Indicated output	Maximum suction	Suction
Sea level	50	30		0.45	
Sea level	50	40		0.75	
Sea level	150	70		1.50	
15,000	50	30		0.45	
15,000	50	50		0.75	
15,000	150	85		1.50	

8. Aneroid air valve closure______________altitude

Table 9-1.—Performance check worksheet for composite and automatic positive pressure diluter demand regulators—(Continued).

9. Oxygen ratio rest (normal)

1	2	3	4	5	6	7	8	9	10	11
Altitude	Oxygen percent	Average percent	Actual output	Indicated output	Corrected indicated output	Act HI	Act LOW	Ind HI	Ind LOW	Reading
	Min. Max.									

10. Pressure breathing test

Altitude	10 l.p.m.	Reading	Minimum pressure	Maximum pressure	100 l.p.m.	Reading	0.01 l.p.m.	Reading
						1.25 Max. decrease		1.25 Max. increase

11. Safety pressure test 10 l.p.m.________________Pressure drop 50 l.p.m.________________

The first performance test that requires a conversion is the flow indicator test. The 25 l.p.m. flow required to perform the test must be converted to inches of water. This is accomplished by use of the oxygen regulator test stand output graph. Since the air valve is in the normal position during this test, the zero altitude air line on the output graph will be used. Reading across the bottom of the output graph, determine the 25 l.p.m. line. Follow the 25 l.p.m. line up the graph until it contacts the zero altitude output air line. From this point, read from right to left across the graph. The figure at the left side of the graph will be the indicated inches of water for the actual 25 l.p.m. flow.

FLOW SUCTION TEST.—The actual flows, test altitudes, and allowable suction figures are taken from the applicable regulator manual. In this case the reference is NavWeps 03-50A-48. (See table 9-2.)

The actual flows must be converted to inches of water, using the output graph for the test stand being used. Since the air valve is in the 100% position during this test, the output oxygen lines on the output graph will be used. The flows are converted in the same manner as for the flow indicator test. Read the liters per minute figures across the bottom of the graph from left to right. From this point, read up the graph to the desired output oxygen altitude line

Table 9-2.—Flow suction characteristics.

Inlet pressure (p.s.i.)	Minimum outlet flow (l.p.m.)	Maximum suction at outlet (inches of water)
Sea level:		
50	30	0.45
50	40	0.75
150	70	1.50
15,000 ft:		
50	30	0.45
50	50	0.75
150	80	1.50

Table 9-3.—Oxygen ratio chart.

Flow at sea level (l.p.m.)	Altitude	Allowable percent oxygen	
		Min.	Max.
15	10,000	6	35
50	10,000	6	35
85	10,000	6	35
5	15,000	14	100
15	15,000	14	42
50	15,000	14	42
15	20,000	24	55
50	20,000	24	55
85	20,000	24	65
5	25,000	40	100
15	25,000	40	80
50	25,000	40	80
85	32,000	98	100

and then right to left across the graph to the inches of water figures. Record the figures in the indicated output column on the performance worksheet flow suction chart.

AIR VALVE CLOSURE.—When performing the air valve closure test, the air valve is in the normal position and a 40 l.p.m. flow is drawn through the regulator. This 40 l.p.m. flow is converted in the same manner as the figures in the previous tests. To convert the actual liters per minute figure to inches of water, use the zero altitude output air line on the output graph.

OXYGEN RATIO TEST.—The oxygen ratio test is the most difficult part of the worksheet to prepare. The purpose of the test is to determine the proportions of air and oxygen passing through the regulator at various altitudes. This will necessitate computing of oxygen percentages and conversion of liters per minute figures to inches of water. To simplify the procedure, the columns in the oxygen ratio chart on the performance worksheet have been numbered. (See table 9-1.) The procedure for filling in each column will be explained separately and individually.

The manual for the specific regulator is used to determine the required test altitudes, output flows, and oxygen percentages. The reference in this case is NavWeps 03-50A-48. (See table 9-3.)

From table 9-3, fill in columns 1, 2, and 4, in the oxygen ratio chart on the performance check worksheet, table 9-1. Column 1 is altitude, column 2 is oxygen percentage, and column 4 is actual output flow.

Column 3 is the average oxygen percentage. This is computed by adding the minimum and maximum oxygen percentage (column 2) and dividing the sum by 2. As an example, the minimum of 6% is added to the maximum of 35%. The sum of the minimum and maximum is 41%. The sum, 41%, is divided by 2. The average oxygen percentage becomes 20.5%. This figure is placed in column 3. Column 3 is to be filled in completely, using this procedure.

Column 5 is the indicated output. The actual output figures in column 4 are converted from liters per minute to inches of water and placed in column 5. This is accomplished by the use of the test stand output graph. Since the air valve is in the normal position during this test, the output air lines on the output graph will be used. Follow the same procedure as in previous conversions, reading the actual flows across the bottom of the graph, up to the appropriate output air line, and to the left across the graph for the indicated inches of water pressure. Complete the conversion of all the figures in column 4 and place them in column 5.

Column 6 is the corrected indicated output. The oxygen conversion graph is used to convert the indicated output figures in column 5 to corrected indicated output. The flowmeters on the test stands are calibrated with air. Since an air and oxygen mixture is being measured during this test, and oxygen is 11.5% heavier than air, this correction must be made. The indicated output, in inches of water, is read across the bottom of the conversion graph. This point is followed up on the graph to the appropriate percentage line and then left to the corrected indicated figure. All the indicated output figures in column 5 are converted to corrected indicated output in this manner and placed in column 6 on the performance check worksheet. This is the output figure used when performing the oxygen ratio test.

Column 7 is the actual high air input. To compute the actual high air figure, subtract the low oxygen percentage (column 2) from 100%. Then multiply the remainder by the actual output (column 4). The answer will be in liters per minute. As an example, 6% is subtracted from 100%. The remainder is 94%. The remainder, 94%, is multiplied by 15, the actual output figure from column 4. The answer is 14.10 l.p.m., which is placed in column 7. Complete column 7 by following this procedure.

Column 8 is the actual low air input. Compute the low air input in the same manner as the high air input except that the high oxygen percentage in column 2 is subtracted from 100% instead of the low oxygen percentage. As an example, 35% is subtracted from 100%. The remainder is 65%. The remainder, 65%, is multiplied by 15, the actual output figure in column 4. The answer is 9.75 l.p.m., which is placed in column 8. Complete column 8 by following this procedure.

Column 9 is the indicated high air input. The actual high air input figures in column 7 are converted to indicated high air input using the test stand input graph. The actual high air input is read across the bottom of the input graph. This point is followed up the graph to the appropriate altitude line and left across the graph to the indicated input figure. This indicated high air input figure is placed in column 9. Complete column 9 by following this procedure.

Column 10 is the indicated low air input. The actual low air input figures in column 8 are converted to indicated low air input in the same manner that the actual high air input figures were converted to indicated high air input. Complete column 10 using this procedure.

Column 11 is used for recording the reading taken from the input manometer on the test stand during the oxygen ratio test. This reading must fall between the indicated high air and indicated low air input figures in columns 9 and 10 for the regulator to satisfactorily pass the oxygen ratio test.

PRESSURE BREATHING TEST.—The purpose of the pressure breathing test is to determine whether the pressure breathing back is delivering the positive pressure in accordance with the positive pressure schedule outlined in NavWeps 03-50A-48. (See table 9-4.)

Table 9-4.—Positive pressure values.

Altitude (feet)	Positive pressure (inches of water)	
	Min.	Max.
35,000	-	3.5
37,000	-	5.7
39,000	-	8.0
40,000	2.0	9.4
41,000	4.0	10.2
41,500	6.0	10.8
42,500	8.0	12.0
43,000	10.0	12.5
50,000	-	18.0

The positive pressure loading at 100 l.p.m. ambient flow must not decrease by more than 1.25 inches of water from the positive pressure loading at 10 l.p.m. ambient flow.

The positive pressure loading at 0.01 l.p.m. ambient flow must not increase more than 1.25 inches of water above the positive pressure loading at 10 l.p.m. ambient flow.

The altitude, minimum pressure, and maximum pressure columns are filled in from table 9-4. The 10 l.p.m., 100 l.p.m., and 0.01 l.p.m. flows must be converted to inches of water Since the regulator is delivering 100% oxygen at pressure breathing altitudes, the output oxygen lines on the output graph are used for this conversion. Follow the same procedure as outlined in previous tests. Since the test stands cannot measure 0.01 l.p.m., a zero flow will be used for this portion of the test.

SAFETY PRESSURE TEST.—The 10 l.p.m. and 50 l.p.m. flows used during the safety pressure test must be converted to inches of water. Since the air valve is in the 100% position during this test, the zero altitude output oxygen line on the output graph will be used to convert the figures. Follow the same procedures as outlined in the previous tests.

Testing Procedure

The composite and automatic positive pressure diluter demand regulators must undergo and pass rigid leak and performance tests. If a regulator does not perform properly, it may cause injury or death to flight personnel. It is the Parachute Rigger's job to insure that service regulators perform properly at all times. Table 9-1 shows a suitable worksheet for all the tests required for these regulators. All leaks must be remedied before proceeding to the performance tests.

Unless otherwise specified, tests must be performed at an atmospheric pressure of 29.92 inches of mercury and at a room temperature of approximately 77° F. If the test conditions are materially different from these, allowances must be made. Unless otherwise specified, all tests are to be conducted with the external oxygen supply valve fully open. After completion of the oxygen regulator tests, disconnect the tube from the outlet and close the external supply valve. Remove the regulator from the inlet. Rotate the safety pressure knob to ON, relieving the trapped oxygen from the regulator through the outlet.

Be sure all the parts of the regulator and all equipment used for testing are absolutely free from oils and grease or any other material that is not approved for use in the presence of high-pressure oxygen. The presence of oil or grease may cause spontaneous combustion and explosion.

PRETESTING.—Before individual tests are made, it is recommended that all regulators be cycled for 30 minutes at approximately 20 l.p.m. with an inlet pressure of 200 p.s.i. and the air valve on NORMAL. This check is performed to show up defects in the regulators that may be the result of improper assembly.

HIGH-PRESSURE LEAK TEST.—The high-pressure oxygen leak test is performed to determine whether or not the parts inside the regulator are leaking. A leak is indicated by a bubble appearing when a film of soapy water is applied to the regulator outlet. The high-pressure leak test is performed with the safety pressure in the OFF position. Apply pressures of 50, 150, and 1,800 p.s.i. to the inlet of the regulator. There must be no leakage indicated when a soap film is drawn over the outlet.

Causes and remedies for high-pressure leakage:

Cause: Leaking inlet valve.

Remedy: Remove the inlet valve assembly and test by dipping in a container of water. If bubbles appear around the pin, rebuild the inlet assembly and replace the pin. If bubbles show around the valve, tighten it to 125 inch-pounds.

Cause: Pressure reducer set too high.

Remedy: Reset the pressure to 55 to 65 p.s.i.

Cause: Leak in the pressure reducer bellows.

Remedy: Replace the pressure reducer bellows.

Cause: Leak around the pressure reducer nut.

Remedy: Replace the packings and tighten the pressure reducer nut.

Cause: Weak demand valve spring.

Remedy: Replace the regulator. The demand valve acts as the pressure safety release on these regulators. Instead of the seat of the demand valve being pushed away from the valve, the seat is lifted away from the valve. With the pressure working on the seat of the demand valve, a weak demand valve spring would allow an escape of oxygen through the valve, even though the pressure reducer is set correctly.

As mentioned before, disassembly of the demand valve on the composite and automatic positive pressure diluter demand regulators is not authorized except at a major overhaul station. The only possible remedy then for a weak demand valve spring would be to turn the regulator in to the Supply Department for major overhaul.

Cause: No play in the ratio lever or pressure breathing back.

If this condition exists, the ratio lever would be exerting pressure on the counterweight lever. The counterweight lever, through linkage, depresses the diaphragm button, lifting the sea away from the demand valve.

Remedy: Readjust the safety pressure so there is a slight play between the end of the shaf and the ratio lever.

Cause: Demand valve lever set too high.

Remedy: Reset the demand valve lever s that it is 33/64 inch below or inside the bottom edge of the case. Use the lever setting gage i available; otherwise use a straightedge and scale, as previously described.

OVERALL LEAK TEST.—The overall leak test is performed only on the 2867 and the 2872 regulators.

With 1,800 p.s.i. applied to the regulator inlet and the safety pressure knob in the OFF position, open the shutoff valve; 1,800 p.s.i. will be indicated on the pressure gage. Close the shutoff valve and remove the regulator from the pressure source. The pressure indicated on the pressure gage must not drop more than 100 p.s.i. in 2 minutes.

The causes and remedies for the overall leak test are the same as for the high-pressure leak test.

SHUTOFF VALVE LEAK TEST.—The shutoff valve leak test is performed only on the 2867 and 2872 regulators.

With the safety pressure rotated to the ON position and the shutoff valve closed, apply 1,800 p.s.i. to the inlet of the regulator. With a soap film over the outlet, there must be no evidence of leakage.

Causes and remedies for shutoff valve leakage:

Cause: Marred shutoff valve seat.

Remedy: Replace the shutoff valve.

OUTWARD LEAK TEST.—The outward leak test is to determine if there is any outward leakage of oxygen from the regulator case.

Testing for outward leaks on all regulators can best be accomplished by use of an outward leak tester which can be manufactured locally. Figure 9-10 illustrates a locally manufactured outward leak tester.

Oxygen pressure is applied to the outlet of the regulator by turning the manual pressure breathing top of the regulator clockwise. The amount of pressure is indicated on the pressure gage. Any outward leakage will act as a flow, and will register on the oxygen manometer.

Procedure for performing the outward leakage test on the composite and automatic positive pressure diluter demand regulators follows:

1. Connect the outlet of the regulator to the hose on the outward leak tester.
2. With the air valve in the NORMAL position, apply 1 inch of water pressure to the regulator outlet.
3. Allowable leakage is 0.5 l.p.m.
4. With the air valve in the 100% position, apply 10 inches of water pressure to the regulator outlet.
5. Allowable leakage is 1.5 l.p.m.

Causes and remedies for outward leakage:

Cause: Leakage through the air check valve on NORMAL. This is caused by a faulty air check valve disc or seat.

Remedy: Replace the air check valve disc or the aneroid housing.

Cause: Leakage through the air check valve on 100%. This is caused by loose air valve housing screws or a faulty housing gasket.

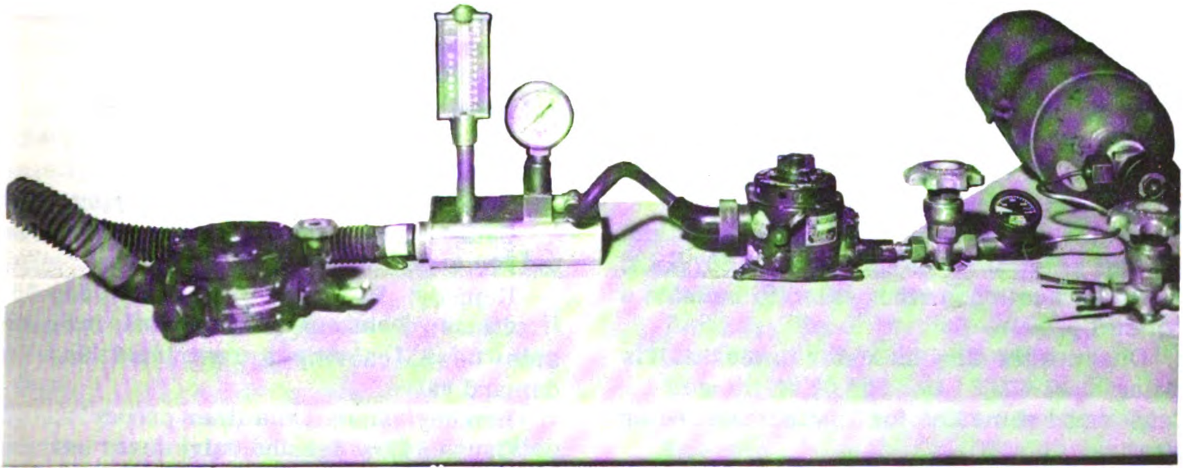


Figure 9-10.—Outward leak tester, manufactured locally.

Remedy: Tighten the air valve housing screws. If necessary, replace the air valve housing gasket.

Cause: Ruptured diaphragm.

Remedy: Replace the diaphragm.

Cause: Faulty diaphragm gasket.

Remedy: Replace the gasket.

Cause: Loose outlet elbow.

Remedy: Tighten outlet screws.

Cause: Chipped knife edge on the air valve lever.

Remedy: Replace the air valve lever.

Cause: Scarred or distorted air valve body gasket.

Remedy: Replace the air valve body gasket.

Cause: Loose screws or subassemblies.

Remedy: Tighten all screws and subassemblies.

INWARD LEAK TEST.—The inward leak test is to determine if there is any ambient air leaking into the regulator case. The inward leak test is performed in the test stand at sea level. The procedure is as follows:

1. Mount the regulator in the test stand with the diaphragm on a horizontal plane.
2. Air valve knob on 100% position.
3. Oxygen supply turned off.
4. Open the outlet valve until 1-inch suction is indicated on the pressure suction manometer. Open the outlet valve with caution as 1-inch suction is easily obtained inside the regulator.
5. Allowable leakage is 0.5 l.p.m. and will be indicated on the output manometer. When using the OTS 565 test stand, any indication of leakage will be considered excessive leakage since is is impossible to measure 0.5 l.p.m. on the manometer.

Causes and remedies for inward leakage will be the same as for outward leakage with the exception of the air check valve assembly. The air check valve opens inward; therefore, it cannot be considered a cause for inward leakage.

FLOW INDICATOR TEST.—The flow indicator test is performed as follows:

1. Set the air valve in the NORMAL position.
2. Apply an inlet pressure of 150 p.s.i.
3. Apply suction to the outlet to indicate a flow of 25 l.p.m.
4. Observe the flow indicator to see that it is operating.

Causes and remedies for flow indicator being inoperative.

Cause: Leaking piston seal.

Remedy: Replace the piston seal.

Cause: Leaking flow indicator gasket.

Remedy: Tighten retaining ring or replace gasket.

FLOW SUCTION TEST.—The flow suction test is performed to measure the amount of suction required to draw a specific flow through the regulator. In order to perform the flow suction test, it will be necessary to complete the flow suction block of the performance worksheet as explained earlier in this chapter.

Flow suction test procedure is as follows:

1. Set the air valve in the 100% position.
2. Adjust the inlet pressure to 50 p.s.i.
3. Open the outlet valve to the first indicated flow.
4. Record the suction indicated on the pressure suction manometer.
5. Open the outlet valve to the next indicated flow.
6. Record the suction reading.
7. Increase the inlet pressure to 150 p.s.i.
8. Open the outlet valve to the next indicated flow.
9. Record the suction reading.
10. Close the outlet valve and adjust the inlet pressure to 50 p.s.i.
11. Open the outlet valve to 10 l.p.m.
12. Place the glass on the chamber.
13. Start the buzzer.
14. Open the bypass valve and ascend t 15,000 feet.
15. Close the bypass valve and set the firs indicated flow with the outlet valve.
16. Record the suction reading.
17. Set the next indicated flow.
18. Record the suction reading.
19. Increase the inlet pressure to 150 p.s.i.
20. Set the next indicated flow.
21. Record the suction reading.
22. Decrease the indicated flow.
23. Open the inlet valve and descend to se level.

Causes and remedies for high suction:

Cause: Pressure reducer pressure set to low.

Remedy: Reset the pressure to 55 to 65 p.s.i.

Cause: Pressure reducer liner installed upside down, causing a restricted flow to th demand valve.

Remedy: Install the liner properly.

Cause: Low demand valve lever setting.

Remedy: Reset the demand valve to 33/64 inch below the edge of the regulator case

Cause: Excessive back pressure from the njector assembly during high flows.

Remedy: Replace the injector spring with a eaker one.

Cause: Strong demand valve spring.

Remedy: Replace the regulator.

ANEROID CLOSURE TEST.—The aneroid losure test is to determine at what altitude the neroid shuts off the flow of ambient air into he regulator.

Procedure for the aneroid closure test is s follows:

1. Set the air valve in the NORMAL posiion.
2. Inlet pressure is 150 p.s.i.
3. Place the glass on the chamber.
4. Open the outlet valve to approximately 0 l.p.m.
5. Observe the altimeter; it should stop limbing between 28,000 and 32,000 feet.
6. If the altimeter continues to climb above 0,000 feet, decrease the outlet flow to 20 l.p.m.
7. When the altimeter stops climbing, or lows to 60 feet in 10 seconds, the aneroid is onsidered closed.
8. Record the altitude on the performance orksheet.
9. Close the outlet valve, open the inlet valve, nd return to sea level.

auses and remedies for the air valve failing to lose or closing too late:

Cause: Cocked aneroid.

Remedy: Replace the aneroid.

Cause: Scarred or dirty throttling plate and eat.

Remedy: Polish with 0000 polishing paper. lean with Freon 113, and dry with clean, oil-free ir. If the throttling plate or seat is scarred too eep, it will necessitate replacement.

Cause: Aneroid and throttling plate too far rom the seat.

Remedy: Readjust the aneroid by turning it lockwise, approximately 1/4 turn per 2,000 feet.

Aneroid air valve closes too soon:

Cause: Aneroid and throttling plate set too lose to the seat.

Remedy: Readjust the aneroid by turning it ounterclockwise, approximately 1/4 turn per ,000 feet.

Adjusting the aneroid is a trial-and-error ethod, but the only possible way to accomplish he adjustment. With a little practice, a proper djustment can usually be made on the first attempt. An ideal aneroid air valve closure is 30,000 feet.

If, when performing the air valve closure test, the altimeter will not indicate a climb, the aneroid and throttling plate is too close to the seat either by adjustment or because of an expanded aneroid. An adjustment will have to be made or the expanded aneroid replaced.

OXYGEN RATIO TEST.—The oxygen ratio test is to determine if the proper mixture of cylinder oxygen and air is being delivered to the user. Oxygen ratios vary for different altitudes and flows. The regulator must meet the percentage requirements listed in the manual for the regulator. Complete the oxygen ratio chart on the performance check worksheet (table 9-1).

Procedure for performing the oxygen ratio test follows:

1. Set the air valve on NORMAL.
2. Inlet pressure is 150 p.s.i.
3. Place the glass on the chamber and ascend to the first test altitude using the outlet valve.
4. Set the corrected indicated output with the outlet valve while adjusting the inlet valve to maintain the correct test altitude.

The altimeter must be holding steady when the readings are taken.

5. Read the input manometer and record the figure in the proper column (column 11) on the performance check worksheet.

Keep in mind that the test stand was calibrated with air; therefore, it will only measure air. If the ratio of air is within the high and low limits, it is understood that the proper amount of oxygen is being delivered.

6. Set all the required flows at the altitude as in steps 4 and 5.
7. Climb to the next test altitude by closing the inlet valve and opening the outlet valve as required.
8. Repeat steps 4, 5, and 6 at each test altitude.

Causes and remedies for incorrect air-oxygen ratio:

High air at 10,000 and 15,000 feet:

Cause: Weak air check valve spring.

Remedy: Turn the adjusting screw in the air check valve retainer clockwise.

Low air at 10,000 and 15,000 feet:

Cause: Strong air check valve spring.

Remedy: Turn the adjusting screw in the air check valve retainer counterclockwise.

Cause: Leaky injector.

Remedy: Tighten the mixing tube to seat the injector tighter on the gasket. Replace the injector gasket or seat as necessary.

Cause: Injector positioned incorrectly.

Remedy: Reposition the injector housing. The slot in the housing should be aligned with the slot in the air valve chamber.

High air at 20,000 feet:

Cause: Excessive throttling plate movement. The distance between the throttling plate and the aneroid housing seat is too great.

Remedy: Replace the shouldering screw with one having a longer shoulder. Place a drop of glyptol on the threads.

Low air at 20,000 feet:

Cause: Insufficient throttling plate movement. The distance between the throttling plate and the aneroid housing seat is not great enough.

Remedy: Replace the shouldering screw with one having a shorter shoulder. Place a drop of glyptol on the threads.

High air at 25,000 and 32,000 feet:

Cause: Aneroid not closing soon enough.

Remedy: Readjust the aneroid clockwise to close sooner.

PRESSURE BREATHING TEST.—The purpose of the pressure breathing test is to insure that the pressure back is delivering the proper positive pressure at the specified altitudes. The pressure back must meet the positive pressure schedule as outlined in the manual for the regulator. Complete the pressure breathing chart on the performance check worksheet (table 9-1) as described earlier in this chapter.

Procedure for performing the pressure breathing test follows:

1. Set the air valve in the NORMAL position.
2. Inlet pressure is 150 p.s.i.
3. Place the glass on the chamber and open the outlet valve to indicate a 10 l.p.m. flow.
4. Open the bypass valve and ascend to the first test altitude.
5. Close the bypass valve, and if necessary, adjust the outlet valve to indicate a 10 l.p.m. flow.
6. Record the pressure suction manometer reading.
7. Increase the outlet flow to 100 l.p.m.
8. Record the pressure suction manometer reading.
9. Decrease the outlet flow to 0.01 l.p.m. (Since 0.01 l.p.m. cannot be measured on the OTS 565 test stand, decrease the outlet flow to zero.)
10. Record the pressure suction manometer reading.
11. Open the outlet valve to indicate 10 l.p.m.
12. Ascend to the next test altitude using the bypass valve.
13. Repeat steps 5 through 10 at each test altitude until the test is completed.
14. Return to sea level using the inlet valve.

Causes and remedies for incorrect pressure breathing pressures:

High pressure back readings:

Cause: Pressure back screwed in too far.

Remedy: Readjust the pressure back counterclockwise.

Prior to performing the pressure breathing test, it is wise to initially set the pressure back. This is accomplished by screwing the pressure back in until a delivery of pressure is noted. Then screw the pressure back out 2 full turns. The final adjustment should be made using the 43,000-foot reading as a guide. Generally, if the 43,000-foot pressure is correct, the other altitude pressures will fall in correctly.

Low-pressure back readings:

Cause: Pressure back not screwed in far enough.

Remedy: Readjust the pressure back clockwise.

If adjustment of the pressure back does not allow the proper calibration, it may be necessary to adjust the ratio lever. Set the clamp farther out toward the end of the slot in the lever to give lower outlet pressures at high altitudes and higher pressures at low altitudes. Set the clamp closer to the center of the lever to obtain the opposite results.

At completion of the adjustment procedure, lock the aneroid cover in place by means of the strap.

SAFETY PRESSURE TEST.—The purpose of the safety pressure test is to determine the amount of positive pressure being delivered by the safety pressure. The safety pressure is manually operated. The purpose of the safety pressure is to prevent inboard mask leakage.

Procedure for performing the safety pressure test follows:

1. Air valve is set in the 100% position.
2. Inlet pressure is 150 p.s.i.

3. Open the outlet valve to indicate a 10 p.m. flow.
4. Actuate the safety pressure.
5. Record the pressure suction manometer ading.

The pressure suction manometer must incate a 1.75 ± 0.25 inches of water.

6. Increase the outlet flow to 50 l.p.m.
7. Record the pressure suction manometer ading. (The pressure drop indicated on the essure suction manometer must not exceed inch of water.)
8. Shut off the safety pressure.
9. Close the outlet valve.

Causes and remedies for high safety preslre readings:

Cause: Excessive spring tension.

Remedy: Decrease the pressure on the ring. Using two wrenches, loosen the stop nut d adjust the spring nut to the desired preslre reading. This operation can be performed ile the regulator is in the test stand with a w passing through the outlet.

Causes and remedies for low safety pressure adings:

Cause: Insufficient spring tension.

Remedy: Increase the pressure on the spring adjusting the spring nut to the desired preslre reading.

Excessive pressure drop with a 50 l.p.m. w would be caused by a weak spring. A ak spring must be replaced with a stronger e. After the desired safety pressure has en attained, tighten the locknut. This will sure a constant spring tension, thereby dering the proper amount of safety pressure the user.

It is imperative that all the aforementioned sts be performed, and all leakage and malnctions be remedied before the regulator is sued for installation in an aircraft.

DILUTER DEMAND OXYGEN REGULATOR (2858 SERIES)

Diluter demand oxygen regulators (Pioneer pe) models 2858-A1, 2858-B1, and 2858-C1 e manufactured by Eclipse-Pioneer Division Bendix Aviation Corporation, Teterboro, w Jersey. They are designed to be operated an input pressure of 1,800 p.s.i. and to give luted (or 100%) oxygen upon demand (inhalation) to a service ceiling of 37,500 feet. This ceiling can be exceeded by 2,000 feet during emergencies for short periods of time only. These regulators are suction diaphragm operated. They automatically mix varying quantities of air and oxygen (the ratio depending upon the altitude) and deliver the quantity demanded upon inhalation. Figure 9-11 is a three-quarter view of the 2858-A1 model.

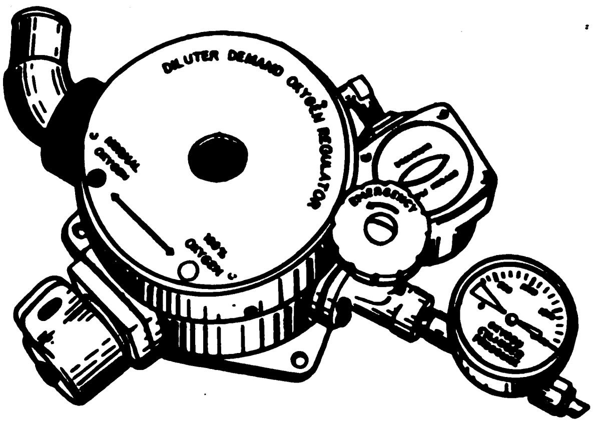


Figure 9-11.—Diluter demand oxygen regulator, model 2858-A1.

Except for a few minor modifications, the 2858 series regulators are of the same basic design. Also the disassembly, repair, and reassembly of these regulators are primarily the same. For a detailed disassembly, cleaning and inspection, and reassembly procedure, refer to the manual for this series, *Operation, Service and Overhaul Instructions Manual, Diluter Demand Oxygen Regulators*, AN03-50A-5.

PERFORMANCE SHEET PREPARATION.—To prepare a performance check worksheet for the 2858 series, follow the same general procedure used to prepare the worksheet for the composite and automatic positive pressure diluter demand regulators. See table 9-5 for a simple, easy-to-use worksheet.

The flow suction chart for the 2858 regulators will be found in the manual for these regulators. (See table 9-6.) The flows are converted in the same manner as for the composite and pressure breathing regulators.

The flows for the emergency flow test are converted using the zero altitude output oxygen line on the test stand output graph since the air valve is in the 100% position during the test.

The only variation in preparing the oxygen ratio chart for the 2858 series regulators is that the individual preparing the chart selects the outlet flows to be used since the ratio chart in the manual does not specify the flows. (See table 9-7.) The three flows required for each altitude must be either two low and one high or two high and one low. The flows are selected by the individual and the combination must alternate from 5,000 to 32,000 feet. For example, on the output column of the worksheet, list 20, 40, 60, (two low and one high), then 80, 60, 40, (two high and one low), and so on until the column is filled. This will give the required high and low flow combinations for each altitude.

The worksheet is filled in and the flows are converted in the same manner as for the worksheet for the composite and pressure breathing regulators.

Test Procedures

The high-pressure leak test (fig. 9-12) is performed as follows:

1. Close the emergency valve.
2. Connect the regulator to a controllable source of pressure.
3. Apply 50 p.s.i. inlet pressure.
4. Soap the outlet of the regulator (no leakage allowed).
5. Allowable bubble distention is 3/16 inch in 10 seconds.
6. Increase the inlet pressure to 500 p.s.i.

Table 9-5.—Performance check worksheet for 2858-A1, -A1A, -B1, and -C1.

Regulator Performance Check Worksheet

2858-A1, -A1A, -B1, -C1

Date ____________ Regulator Type ____________ Test stand No. ____________

Operator ____________ Regulator serial No. ____________

1. High-pressure leak ____________

2. Outward leak test: Normal ____________ 100% ____________

3. Inward leak test ____________

4. Flow suction test (100%)

Altitude (feet)	Inlet pressure	Actual output	Indicated output	Maximum suction	Suction reading
Sea level	50	30		0.40	
Sea level	50	40		0.97	
Sea level	150	70		1.50	
15,000	50	30		0.40	
15,000	50	50		0.97	
15,000	150	85		1.50	

5. Emergency flow test: 100 p.s.i. - 30 l.p.m. ________ 40 l.p.m. ________ Reading ____________

6. Aneroid air valve closure ____________ altitude

7. Oxygen ratio test

Table 9-5.—Performance check worksheet for 2858-A1, -A1A, -B1, and -C1—Continued.

1	2		3	4	5	6	7	8	9	10	11
Altitude	Oxygen percent		Average percent	Actual output	Indicated output	Corrected indicated output	Act HI	Act LOW	Ind HI	Ind LOW	Reading
	HI	LOW									

7. Allowable bubble distention is 3/16 inch in 10 seconds.

It is rather difficult to measure a 3/16-inch bubble. If there is any distention, especially if it continues to expand, it can be considered excessive leakage. To determine if the leak is through or around the working parts of the regulator, remove the elbow and place a soap film over the end of the venturi. If there is an expansion of the soap film, the leak is through the working parts. If there is no expansion of the soap film, the leak is around the working parts of the regulator.

Causes and remedies for high-pressure leaks through the working parts:

Cause: Demand valve set too high.

Remedy: Reset the demand valve lever to 11/64 inch above the top of the regulator case.

Cause: Demand valve not seating.

Remedy: Replace the demand valve seat.

Cause: Bent or burred demand valve stem.

Remedy: Replace the demand valve stem.

Cause: Wrinkled or tight diaphragm.

Remedy: Reposition or replace the diaphragm.

Causes and remedies for high-pressure leaks around the working parts:

Cause: Defective inlet orifice gasket.

Remedy: Replace the inlet orifice gasket.

Cause: Leakage around the pressure reducer chamber.

Remedy: Tighten screws, if necessary, and replace gaskets.

Table 9-6.—Flow suction characteristics.

Inlet pressure (p.s.i.)	Actual flow (l.p.m.)	Maximum suction (inches of water)
50 to max.	0 to 30	0.40
50 to max.	50*	0.97
150 to max.	85**	1.50

*40 below 15,000 feet
**70 below 15,000 feet

Table 9-7.—Required oxygen percentages at various altitudes.

Altitude (feet)	Ratio of cylinder oxygen supplied to total gas delivered.	
	Total gas flow 20 to 50 l.p.m.	Total gas flow 51 to 85 l.p.m.
5,000	0.01 to 0.30 inclusive	0.01 to 0.40 inclusive
10,000	0.06 to 0.30 inclusive	0.06 to 0.40 inclusive
15,000	0.14 to 0.32 inclusive	0.14 to 0.45 inclusive
20,000	0.24 to 0.42 inclusive	0.24 to 0.65 inclusive
25,000	0.40 to 0.80 inclusive	0.40 to 0.90 inclusive
28,000	0.70 to 1.00 inclusive	0.70 to 1.00 inclusive
32,000	0.98 to 1.00 inclusive	0.98 to 1.00 inclusive

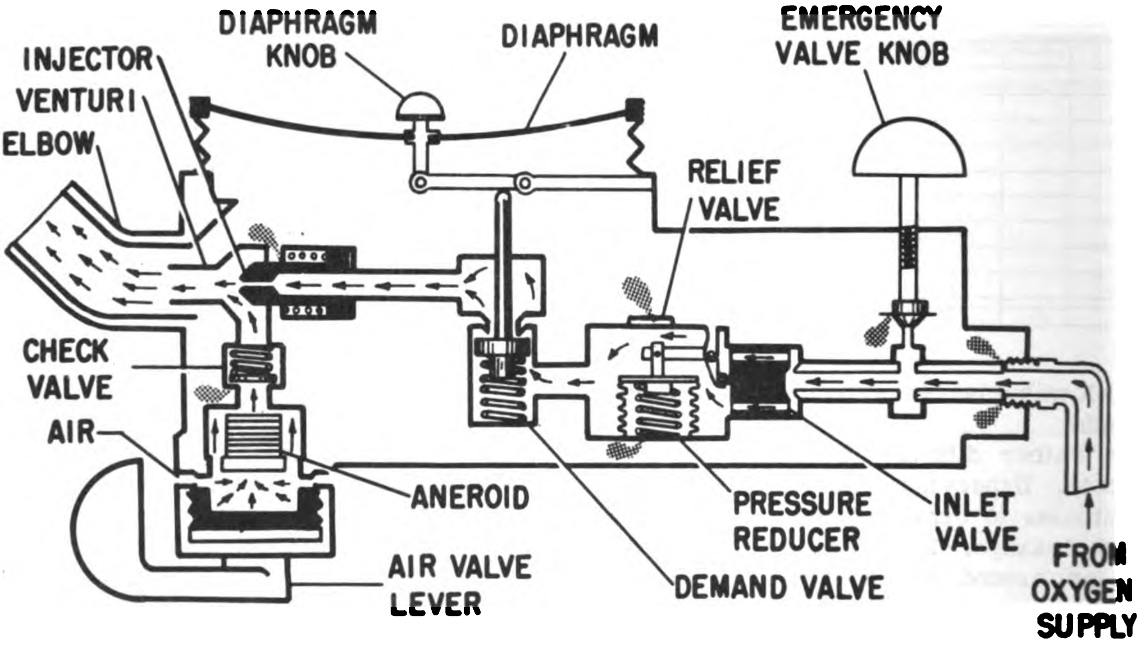


Figure 9-12.—Schematic of 2858 regulators—showing various high-pressure leaks through and around the working parts.

Cause: Leaking inlet valve.

Remedy: Readjust the inlet valve setting or replace the entire inlet valve assembly.

Cause: Leakage around the demand valve chamber

Remedy: Tighten screws, if necessary, and replace gaskets.

Cause: Leakage through the emergency valve channel.

Remedy: Replace packings and tighten emergency valve shaft.

Cause: Leakage through the pressure reducer adjusting screw.

Remedy: Replace the entire pressure reducer assembly.

OUTWARD LEAK TEST.—The procedure for performing the outward leak test is as follows:

1. Connect the regulator outlet to the outward leak tester.
2. With the air valve on NORMAL, apply 1-inch water pressure to the regulator outlet.
3. Allowable leakage is 0.8 l.p.m.

4. With the air valve on 100%, apply 10 ches water pressure to the regulator outlet.

5. Allowable leakage is 0.3 l.p.m.

Causes and remedies for outward leakage ould be generally the same as those for the mposite and pressure breathing regulators.

INWARD LEAK TEST.—The inward leak test performed in the same manner as the com- site and pressure breathing regulators. uses and remedies are also generally the me.

FLOW SUCTION TEST.—To perform the flow ction test, the flow suction chart on the per- rmance check worksheet must be filled in. ee tables 9-5 and 9-6.) The conversion of ac- al flows to indicated inches of water is ac- mplished in the same manner as for the com- site and pressure breathing regulators. The w suction test is also performed in the same anner.

Causes and remedies for high suction:

Cause: Low-pressure reducer setting.

Remedy: Reset the pressure reducer to 48 1 p.s.i.

Cause: Stiff demand valve spring.

Remedy: Replace the demand valve spring ith a weaker one.

Cause: High-pressure reducer setting.

Remedy: Reset the pressure reducer to 48 1 p.s.i.

Cause: Stiff injector spring.

Remedy: Replace the spring with a weaker ne.

Cause: Demand valve lever set too low.

Remedy: Reset the demand valve to 11/64 ch above the edge of the regulator case.

Cause: Pressure reducer shutting off above rizontal.

Remedy: Reset the pressure reducer pin that the hole is 9/64 inch above the surface the bellows cap.

EMERGENCY FLOW TEST.—The emer- ncy flow test is performed to measure in p.m. the amount of oxygen flow delivered hen the emergency valve is fully open.

Procedure for performing the emergency ow test on the 2858 series regulator follows:

1. Mount the regulator in the test stand.
2. Air valve 100%, emergency valve OFF.
3. Set the inlet pressure at 100 p.s.i.
4. Open the outlet valve to indicate 50 l.p.m. flow higher than the expected emergency ow).
5. Slowly open the emergency valve fully.
6. Slowly close the outlet valve until the pressure suction manometer indicates 0 or slightly on the pressure side.
7. Emergency flow will be indicated on the output manometer (30 to 40 l.p.m.).
8. Close the emergency valve, then the outlet valve.
9. In accordance with *Airframes Accessories Bulletin* 7-58, all 2858 series regulators will deliver 30 to 40 l.p.m. emergency flow.

Causes and remedies for incorrect emergency flow:

Low emergency flow:

Cause: Obstructed or dirty orifice.

Remedy: Clean by blowing out with dry, oil-free air.

Cause: Clogged inlet screen.

Remedy: Clean or replace the screen.

Cause: Low inlet pressure.

Remedy: Reset the inlet pressure.

Cause: Leaking emergency valve assembly.

Remedy: Tighten stuffing box nut; replace packings.

High emergency flow:

Cause: Damaged emergency valve orifice.

Remedy: Replace the emergency valve assembly.

Cause: High inlet pressure.

Remedy: Reset the inlet pressure.

If none of the listed causes are found to be the cause of a high or low flow, the emergency orifice is of improper dimension and the complete emergency valve assembly must be replaced.

ANEROID CLOSURE TEST.—The procedure for the aneroid closure test is the same as for the composite and pressure breathing regulators. Also, the causes and remedies for the aneroid not closing, closing too early, or too late are the same.

OXYGEN RATIO TEST.—The procedure for performing the oxygen ratio test is the same as for the composite and pressure breathing regulators. The procedure for completing the performance check worksheet is also the same. The only exception is that the altitudes, oxygen percentages, and actual flows are taken from the ratio chart in the manual for the 2858 regulator. (See table 9-7.)

Causes and remedies for incorrect air-oxygen ratio:

High air at 5,000, 10,000, and 15,000 feet:

Cause: Weak air check valve spring.

Remedy: Stretch the air check valve spring slightly.

Low air at 5,000, 10,000, and 15,000 feet:

Cause: Strong air check valve spring.

Remedy: Shorten the spring by cutting approximately 1/4 inch off one end.

Cause: Leaking injector assembly.

Remedy: Tighten the venturi over the injector assembly housing. If necessary, replace the injector seat and injector gasket.

High air at 20,000 feet:

Cause: Throttling plate too far from the housing seat.

Remedy: Loosen the plate retaining nut a few threads and place a drop of glyptol on the threads to prevent further loosening from vibration. If available, replace the plate retaining nut with one having a longer shoulder. Either of these remedies will place the throttling plate closer to the air valve housing seat. (See fig. 9-13.)

Low air at 20,000 feet:

Cause: Throttling plate too close to the housing seat.

Remedy: Replace the plate retaining nut with one having a shorter shoulder.

Cause: Leaking injector.

Remedy: Tighten the venturi or replace the injector gasket.

High air at 25,000 feet and 28,000 feet:

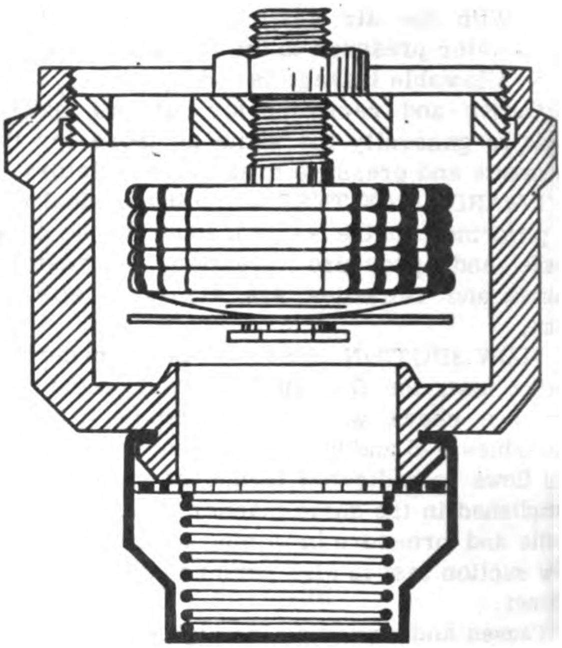


Figure 9-13.—Cutaway of air valve and throttling plate assembly.

Cause: Aneroid air valve closes too late.

Remedy: Readjust the aneroid clockwise to close sooner.

Low air at 25,000 feet and 28,000 feet:

Cause: Aneroid air valve closes too soon.

Remedy: Readjust the air valve counter-clockwise to close later.

Cause: Strong air check valve spring.

Remedy: Clip off 1/4 inch of the air check valve spring.

CHAPTER 10

OXYGEN REGULATORS—CONTINUED

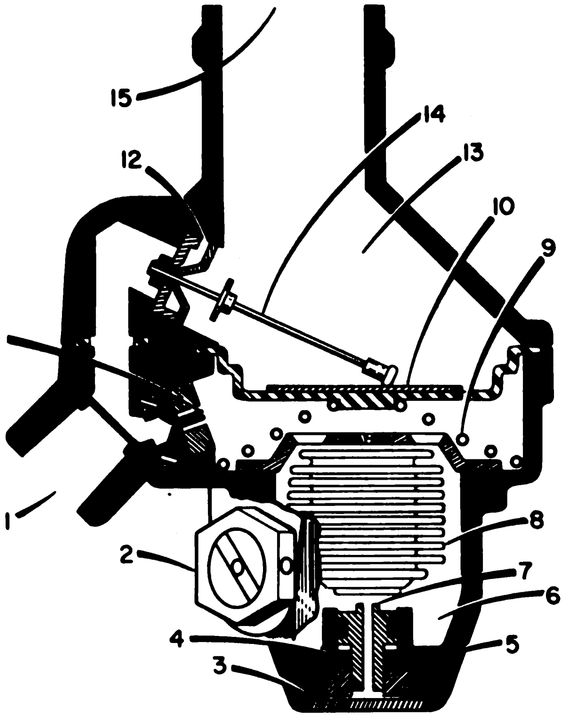
AUTOMATIC PRESSURE OXYGEN BREATHING REGULATORS (FIREWEL F1732)

Description

The F1732 (Firewel) miniature oxygen :eathing regulator is personnel mounted and used both in the inflight and bailout or emer-:ncy conditions. The regulator is so designed at with an inlet pressure of 40 to 90 p.s.i., it ill deliver 100 percent oxygen automatically the user between the altitudes of 0 to 50,000 et. In addition, the regulator incorporates itomatic safety pressure buildup to a maxi-um of 2 inches of water below 35,000 feet and itomatic pressure breathing for altitudes above ,000 feet. It is designed to integrate with the -13A oxygen breathing mask. The regulator isembly weighs 4 ounces and is approximately inches in length and 2 1/2 inches in width.

The F1732 miniature regulator consists of demand valve assembly, demand diaphragm ifety pressure spring, pressure breathing ieroid, oxygen inlet bleed orifice, aneroid :nt outlet, aneroid chamber, and relief valve. ee fig. 10-1.)

SAFETY PRESSURE.—An unbalance of the essures on either side of the demand dia-iragm will cause movement of the diaphragm the direction of the lowest pressure. The rce of the safety pressure spring (maximum 2 inches of water pressure) causes motion the demand diaphragm in the direction of the mand chamber. Motion in this direction uses actuation of the demand valve, thereby imitting oxygen from the 40 to 90 p.s.i. source the regulator outlet and consequently to the -13A oxygen mask. When the force on the :mand chamber side of the diaphragm (due to e mask pressure) is equal to the force on the ieroid chamber side of the diaphragm (due to e safety pressure spring) the diaphragm be-mes balanced and the demand valve closes. this action a safety pressure of a maximum of 2 inches of water is maintained in the oxygen mask.



1. Oxygen inlet.
2. Aneroid chamber relief valve.
3. Protective screen.
4. Aneroid adjusting screw.
5. Locknut of aneroid adjusting screw.
6. Aneroid chamber.
7. Aneroid vent hole.
8. Aneroid.
9. Safety pressure spring.
10. Demand diaphragm.
11. Oxygen inlet bleed orifice.
12. Injector slot.
13. Demand chamber.
14. Demand valve stem.
15. Regulator outlet.

Figure 10-1.—Cutaway view of automatic pressure breathing regulator Part No. F1732 (Firewel).

INHALATION.—The decrease in pressure in the demand chamber, due to inhalation, causes a motion of the demand diaphragm in the direction of the demand chamber. This will actuate the demand valve, allowing the oxygen required for inhalation to pass into the A-13A oxygen mask.

EXHALATION.—The increase in pressure in the demand chamber, due to exhalation, causes a motion of the demand diaphragm in the direction of the aneroid chamber. This motion allows the demand valve to close so that exhalation can be accomplished through the pressure compensated exhalation valve of the A-13A mask.

PRESSURE BREATHING.—The aneroid or pressure breathing control chamber consists of an aneroid preset to begin expanding at approximately 35,000 feet. Oxygen is continually transmitted from the 40 to 90 p.s.i. oxygen source through the oxygen inlet bleed orifice to the aneroid chamber and finally exhausted to ambient atmosphere through the aneroid vent outlet. Since the oxygen flow through the bleed orifice is minute (approximately 150 cc. per minute) and since this oxygen is continually exhausted to the ambient atmosphere, the aneroid chamber remains at essentially ambient pressures. However, as pressure breathing altitudes are approached, the aneroid expands and gradually closes the aneroid vent outlet. This will increase the pressure maintained in the aneroid chamber, consequently backloading the aneroid side of the demand diaphragm with the same pressure.

The unbalance of the diaphragm causes motion of the diaphragm in the direction of the demand chamber, thereby actuating the demand valve and allowing oxygen to flow into the oxygen mask. When the force on the demand chamber side of the diaphragm (due to the mask pressure) is equal to the force on the aneroid side of the diaphragm (due to the aneroid chamber pressure) the diaphragm becomes balanced and the demand valve closes. By this action the pressures are maintained in the oxygen mask for the altitudes shown in table 10-1 at ambient flows of 10 l.p.m.

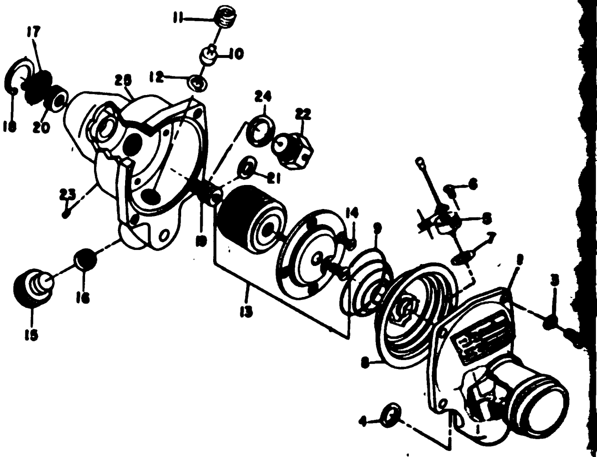
Disassembly

While disassembling the F1732 regulator, it is important that all parts be kept in a clean and dust-free area. Refer to the exploded view, figure 10-2, and disassemble in the order of the key index numbers, using the following special tools as necessary:

F2513 Ring hook (to remove the filter from regulator inlet).

Table 10-1.—Specified altitudes and the minimum and maximum mask pressure in inches of water.

Pressure altitude in feet	Mask pressure inches of water	
	Minimum	Maximum
35,000		3.5
37,000		5.7
39,000		8.0
40,200	2.0	9.4
41,000	4.0	10.2
41,500	6.0	10.8
42,500	8.0	12.0
43,000	10.0	12.5
50,000		18.0



1. Body.
2. Screw.
3. Washer.
4. O-ring.
5. Demand valve assembly.
6. Screw.
7. Gasket.
8. Diaphragm assembly.
9. Spring.
10. Orifice assembly.
11. Locknut.
12. O-ring.
13. Aneroid and mounting plate assembly.
14. Screw.
15. Plug, 1/8-inch pipe dust.
16. Filter.
17. Screen.
18. Ring.
19. Valve, adjustable aneroid.
20. Locknut.
21. O-ring.
22. Valve assembly, popoff.
23. Screw.
24. O-ring.
25. Cover.

Figure 10-2.—Exploded view of miniature automatic pressure breathing regulator.

F2515 Punch (to secure filter to regulator inlet).
F2516 Wrench (to secure orifice locknut to body).
F2514 Screwdriver (used in conjunction with wrench above to adjust the adjustable aneroid valve and its locknut).

DEMAND CHAMBER.—Disassemble the regulator by removing the four housing screws that hold the demand chamber and aneroid pressure chamber together. Lay aside the aneroid pressure chamber after removing the spring and diaphragm. Examine the demand diaphragm for tears, nicks, holes, and distortion. Examine the demand valve housing with particular attention to the positioning of the demand valve assembly. Remove the two demand valve hold-down screws. Remove the demand valve assembly by applying oxygen pressure to the regulator inlet. NEVER PULL ON VALVE STEM TO REMOVE VALVE. Remove the demand valve gasket located in the demand valve well and examine for abuse.

ANEROID PRESSURE CHAMBER.—Remove the four aneroid cover screws. Turn the aneroid housing over and the aneroid and top cover will come out. DO NOT SHOCK ANEROID OR THE ANEROID WILL BECOME SPRUNG.

Disassembly Inspection

Inspect the mating surfaces of the body (1) and cover (25). They must be free of nicks, burrs, and scratches. Inspect all threaded areas of the body and cover to see that they are clean and serviceable.

Inspect the demand valve seat (5) to see that the silicone compound is securely bonded to the seat. Inspect silicone surface for cuts or abrasions. The demand valve guide (pressure-fitted into the demand valve seat) must be properly seated. The vent of the demand valve guide must be 180 degrees opposite the rectangular injector port of the demand valve seat.

Inspect to see that the tip and deflector plate are firmly in place on the stem. Check the dimensions between the face of the deflector plate and the face of the guide. This dimension must be 7/32 inch. Check the demand valve stem for straightness, and check to see that it tilts freely. All areas of the demand valve assembly must be free of nicks, scratches, and abrasions. If any of the above conditions are not fulfilled, replace the demand valve assembly.

Inspect the seat of the adjustable aneroid valve (19). It must be smooth and free of nicks and scratches, and the threads must be clean and serviceable.

Carefully inspect the aneroid assembly (13). With the aneroid mounting plate removed, check the length of the aneroid (do not include the silicone valve seat). This dimension must be 0.616 ±0.010 inch. Inspect the aneroid bellows for dents or scratches. Check the aneroid to see that the silicone seat is free of nicks and abrasions, and that the seat is securely bonded to the aneroid. Check the mating surfaces of the aneroid and aneroid mounting plate. They must be free of nicks, burrs, and scratches. If any of these conditions are not fulfilled, replace the aneroid assembly.

Inspect the spring (9) to see that the coils are not distorted. Inspect the popoff valve assembly (22). It must be free of nicks, burrs, and scratches, and the threads must be clean and serviceable.

Cleaning

Clean all metal parts, using cleaning agent, MIL-C-8638(Aer). Dry with a blast of clean, dry, oil-free air.

At the 250-hour overhaul, clean the diaphragm assembly (8) with a lightly dampened cloth, using trichlorethylene, MIL-T-7003. DO NOT IMMERSE THE DIAPHRAGM ASSEMBLY.

Replacement of Parts and Reassembly

REPLACEMENT OF PARTS.—At the 250-hour overhaul, the demand valve assembly (5) and filter (16) are replaced. At the 500-hour overhaul, the diaphragm (8), orifice (10), filter (16), and demand valve assembly (5) are replaced. (See fig. 10-2.) Replace all parts that do not meet inspection standards. Also replace those parts as determined by test procedures. No lubrication is necessary on any part of this regulator.

REASSEMBLY.—Reassembly of the F1732 regulator is essentially the reverse of disassembly, with the following exceptions:

Carefully assemble the demand valve assembly (5) to the body (1), and adjust it so that the rectangular injector port in the seat of the demand valve assembly is exposed to one-third the width of the slot in the body.

After attaching the demand valve assembly to the body, check to see that the vent in the guide of the demand valve assembly has not shifted. This vent must be 180 degrees opposite the rectangular slot in the seat of the demand valve assembly.

To assemble the orifice (10) to the cover (25) with locknut (11), refer to the special tools listed and use applicable tool. The spring (9) must be properly seated when assembled to the cover. After assembly, gently depress the spring within the cover and check to see that the spring action is not impeded in any way. Check in particular the area of the orifice for any .obstruction to spring action. If spring action is impeded, reseat the spring within the cover to ideal position.

Referring to figure 10-3, reassemble the cover and spring to the body and diaphragm by engaging the top conical of the spring with the silicone centering disc of the diaphragm assembly, and carefully align the cover to the body. Before securing the cover to the body, be absolutely certain that the diaphragm is properly seated in the diaphragm counterbore of the cover. A careful examination of the mating surfaces of the cover and body, as they are hand held in the assembled position, will indicate proper or improper alignment of these parts. Do not secure cover to body until it is determined that the proper alignment is obtained.

To assemble the new filter to the cover, refer to the special tools listed and use the applicable tool for spreading the ring of the filter to secure it to the cover. The screen and snapring are not assembled to the cover until after the test procedures are performed.

Test Procedures

MALFUNCTION.—Mask pressure continually builds up at altitudes below 35,000 feet.

The test setup is with regulator outlet flow valve shut off.

Cause: Silicone seat on the demand valve assembly worn, cut, or dirty.

Remedy: Inspect demand valve seat and assembly with a magnifying glass. If any defects are present on the silicone seat or demand valve, replace demand valve assembly.

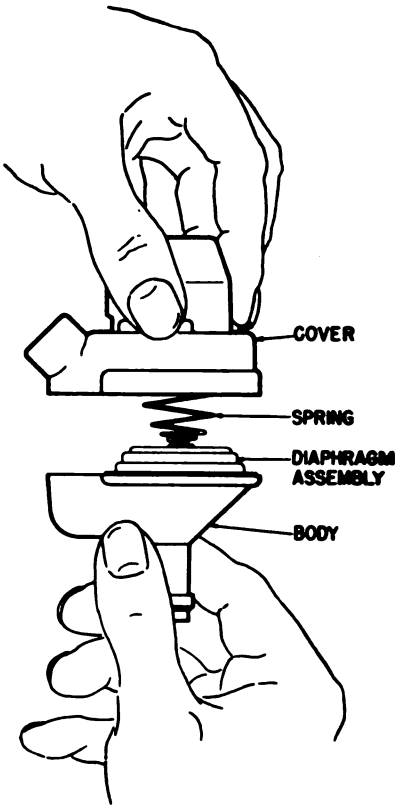


Figure 10-3.—Reassembly procedure for cover, spring, diaphragm, and body.

Cause: Demand valve stem bent.

Remedy: Replace the demand valve assembly.

Cause: Demand valve assembly misaligned in relation to the demand valve gasket. Demand valve screws improperly tightened.

Remedy: Demand valve may have been inserted incorrectly during assembly. If this is the case, the demand valve assembly will be in a cocked position. Correct this by aligning demand valve on demand valve gasket. Check by applying oxygen pressure to regulator inlet.

Cause: Demand valve gasket worn, cut, or dirty.

Remedy: Replace gasket if worn or cut. If dirty, wipe clean.

Cause: Sprung aneroid. This causes the aneroid vent hole to be closed and pressure to build up behind the demand diaphragm. The mask pressure will build up and hold at approximately 18 inches of water due to action of the preset relief valve.

Remedy: Remove the aneroid from the housing. Hold the aneroid between the thumb (on aneroid cover) and index finger (on silicone seat) and squeeze. If the aneroid depresses from this pressure, the aneroid is sprung and must be replaced.

Cause: Hole in diaphragm. This allows gas to escape through the diaphragm. The spring force then holds the diaphragm against the demand valve, keeping it in the open position.

Remedy: Replace the diaphragm.

MALFUNCTION.—Regulator delivers more than the required 2 inches of water, and holds static above 2 inches of water.

Test setup is with regulator outlet flow valve shut off.

Cause: Safety pressure spring too strong.

Remedy: Replace the spring.

Cause: Oxygen inlet bleed is in excess of 150 cc. per minute flow, causing an increase of pressure on back of the demand diaphragm.

Remedy: Replace the oxygen bleed orifice.

MALFUNCTION.—Regulator outlet pressure negative for ambient flows less than 30 l.p.m.

The test setup is in accordance with figure 10-4, with the regulator outlet flow valve set at various flow rates between 10 and 30 l.p.m.

Cause: Safety pressure spring too weak.

Remedy: Replace the spring.

MALFUNCTION.—Regulator operates satisfactorily at low flows, but the regulator outlet pressures are negative at ambient flows less than 100 l.p.m.

The test setup is with the regulator outlet flow valve set at various flow rates up to 100 l.p.m.

Cause: Demand valve injector slot closed too much.

Remedy: Disassemble the demand chamber from the aneroid pressure chamber. Loosen the two demand valve holddown screws and maneuver the demand valve so that the injector slot is from 1/2 to 3/4 open or, if necessary, fully open. Retighten holddown screws and retest. Be careful to correctly align the demand valve and gasket.

MALFUNCTION.—Regulator relief valve does not relieve when mask pressure is in excess of 18 inches of water.

Test setup is in accordance with figure 10-4, with the regulator outlet flow valve shut off and aneroid vent hole blocked off with finger.

Cause: Setting of relief valve too high.

Remedy: Back off the relief valve adjusting screw until the relief valve opens between 8 to 17 inches of water at sea level. Best optimum setting is between 11 and 12 inches of water. Then test at 50,000 foot altitude noting if the relief valve opens at 16 ± 2 inches of water. Drop altitude to determine that the relief valve closes at 11 inches of water.

MALFUNCTION.—Regulator relief valve relieves before the desired range of 16 ± 2 inches of water at altitude and 8 to 17 inches of water at sea level.

Test setup is with the regulator outlet flow valve shut off, and the aneroid vent hole blocked off with finger.

Cause: Relief valve adjusting screw improperly set.

Remedy: Loosen Allen screw on the relief valve body and tighten the relief valve adjusting nut in clockwise direction.

Cause: Leak at relief valve O-ring where the relief valve body is jointed to the regulator body.

Remedy: Tighten valve into the body, or replace the O-ring.

Cause: Leak at joint of demand valve body and aneroid housing around the diaphragm.

Remedy: Tighten the 4 housing screws, being sure that the diaphragm did not fold on the initial assembly.

Cause: Hole in the diaphragm.

Remedy: Replace the diaphragm.

Cause: Oxygen inlet bleed orifice plugged.

Remedy: Replace the oxygen bleed orifice.

Cause: Excessive low-pressure supply.

Remedy: Bring test stand inlet supply pressure to 40-90 p.s.i. Also examine the inlet screen for dirt or other matter which may block inlet pressure flow.

NOTE: If none of the remedies are applicable, replace the relief valve in its entirety.

Altitude Difficulties

MALFUNCTION.—Pressure breathing cuts in below 35,000 feet or mask pressure builds up in excess to pressures listed in table 10-1.

Test setup is in accordance with figure 10-4, at altitudes above 35,000 feet. Regulator outlet flow set for 10 l.p.m. ambient flow.

Cause: Aneroid adjusting screw down too far in the body.

Remedy: Back off aneroid adjusting screw locknut. Back off aneroid adjusting screw until desired range is reached.

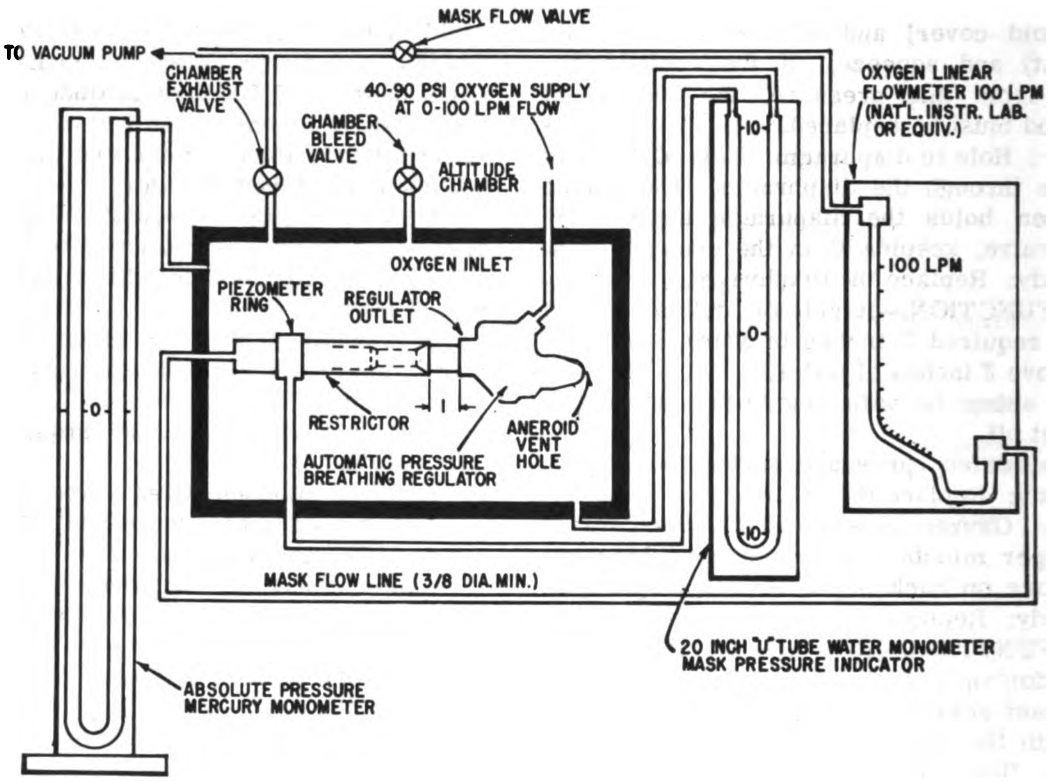

MASK FLOW VALVE
TO VACUUM PUMP
CHAMBER EXHAUST VALVE
40-90 PSI OXYGEN SUPPLY AT 0-100 LPM FLOW
OXYGEN LINEAR FLOWMETER 100 LPM (NAT'L. INSTR. LAB. OR EQUIV.)
CHAMBER BLEED VALVE
ALTITUDE CHAMBER
10
100 LPM
OXYGEN INLET
PIEZOMETER RING
REGULATOR OUTLET
0
0
RESTRICTOR
ANEROID VENT HOLE
AUTOMATIC PRESSURE BREATHING REGULATOR
10
MASK FLOW LINE (3/8 DIA. MIN.)
20 INCH 'U' TUBE WATER MONOMETER MASK PRESSURE INDICATOR
ABSOLUTE PRESSURE MERCURY MONOMETER

Figure 10-4.—Schematic test diagram.

Cause: Seat end of aneroid adjusting screw too long.

Remedy: Remove aneroid adjusting screw and grind down the seat with emery cloth.

Cause: Aneroid silicone seat may be too thick.

Remedy: Remove and replace silicone seat.

Cause: Aneroid sprung.

Remedy: Sprung aneroid is evident if it is possible to compress it by hand. If this is the case, replace the aneroid and properly adjust the new one to the desired altitude range.

MALFUNCTION.—Pressure breathing cuts in above 29,000 feet or mask pressures are less than those listed in table 10-1.

Test setup is in accordance with figure 10-4, at altitudes above 39,000 feet. Regulator outlet flow valve set at 10 l.p.m. ambient flow.

Cause: Aneroid adjusting screw too far out of the body.

Remedy: Loosen aneroid adjusting screw locknut. Tighten the aneroid adjusting screw until desired closing range is noted.

Cause: Aneroid silicone seat may be worn, cut, or dirty.

Remedy: If silicone seat shows any evidence of being worn or cut, replace. If dirty, clean with recommended specified cleaner. It is possible that a minute particle of dirt may penetrate through the aneroid adjusting screw vent hole and lodge between the aneroid adjusting screw seat end and silicone seat, preventing the aneroid from closing properly.

Cause: Case may be leaking.

Remedy: Examine at ground level by applying soapy water solution to mating joint of demand valve chamber and aneroid chamber. With pressure applied to the regulator inlet, hold finger over the aneroid vent hole and relief valve.

Cause: Oxygen inlet bleed orifice stopped or retarded.

Remedy: Replace the bleed orifice.

Cause: The relief valve leaking below popoff pressure.

Remedy: Readjust the popoff valve and, if this does not work, replace the relief valve in its entirety.

Cause: Diaphragm has a minute hole in it.
Remedy: Replace the diaphragm.
Cause: Excessively low test stand inlet pressure.
Remedy: Increase the test stand inlet pressure to 40-90 p.s.i.

Attaching the F1732 Regulator to the A-13A Oxygen Breathing Mask

The F1732 miniature regulator is designed to be integrated with the A-13A oxygen breathing mask, as shown in figure 10-5. The procedure for integrating the regulator, breathing tube, and communication cables are as follows:

Replace the existing A-13A mask breathing tube with the miniature breathing regulator by inserting the outlet of the regulator into the mask inlet port. Clamp the regulator to the mask with a hose clamp.

Connect the oxygen hose to the oxygen inlet supply port of the regulator. The oxygen hose contains four wire conductors fabricated into the wall of the hose, which emerge from the regulator end of the hose as two cables. The cable containing the red and green conductors is attached directly to the mask microphone. (See fig. 10-5.) The cable containing the black and white conductors is attached to a female jack which, in turn, is connected to the existing headset plug.

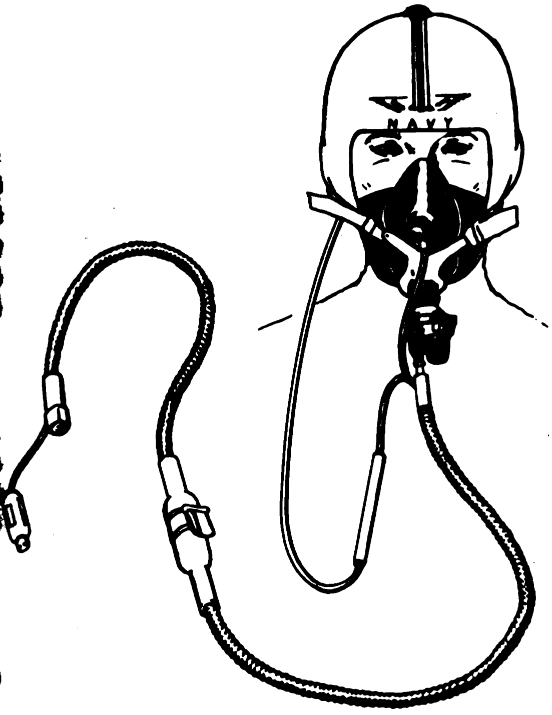


Figure 10-5.—Firewel miniature oxygen breathing regulator integrated with A-13A mask.

BENDIX 29211 B-1 AND C-1 MINIATURE REGULATORS

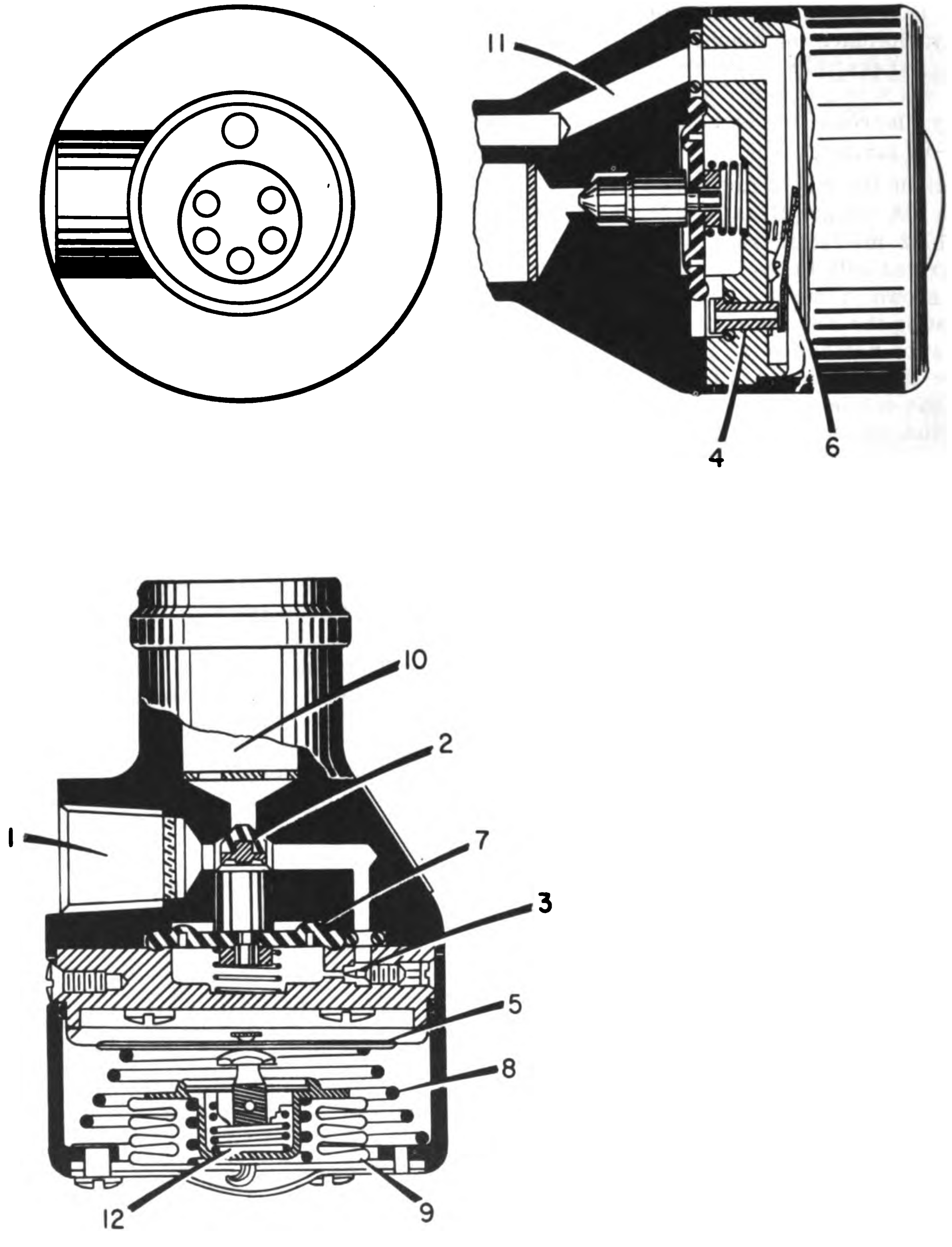
Description

The 29211 B-1 and C-1 oxygen breathing regulators are mounted on the body for use both in flight and in case of emergency. They are so designed that with an inlet pressure of 40 to 90 p.s.i. they will deliver 100 percent oxygen automatically to the user, between the altitudes of 0 to 50,000 feet. The regulators incorporate automatic safety pressure buildup to a maximum of 2 inches of water below 35,000 feet and automatic pressure breathing for altitudes above 35,000 feet. They are designed to be integrated with the A-13A oxygen breathing mask. The regulators weigh 3 ounces, and are about 2 1/3 inches in length and 1 33/64 inches in diameter. They are designed to operate between a temperature range of -65° F. to +160° F.

The 29211 B-1 miniature regulator consists of a demand valve, demand valve diaphragm, breathing diaphragm, pilot valve, pilot valve lever, safety pressure spring, evacuated aneroid, and adjustable orifice, as shown in figure 10-6.

Operation

SAFETY PRESSURE.—The force of the safety pressure spring (maximum of 2 inches of water pressure) causes motion of the breathing diaphragm to the pilot lever, opening the pilot valve. When the pilot valve opens, oxygen is bled from the demand valve chamber at a rate faster than the leakage through the orifice; thus causing an unbalance of pressure on the demand diaphragm. This movement of the diaphragm will be in the direction of the lowest pressure. This movement causes the opening of the demand valve, and oxygen flows to the mask. The pressure at the outlet is sent through the sensing line to the breathing diaphragm. When the mask pressure on the demand side of the diaphragm is equal to the safety spring pressure on the aneroid side of the diaphragm, the system is balanced and the pilot and demand valves will close. By this action, a safety pressure of



1. Regulator inlet.
2. Demand valve.
3. Adjustable orifice.
4. Pilot valve.
5. Breathing diaphragm.
6. Pilot valve lever.
7. Demand valve diaphragm.
8. Safety pressure spring.
9. Aneroid.
10. Demand chamber.
11. Sensing line.
12. Aneroid stop spring.

Figure 10-6.—The 29211 B-1 oxygen regulator.

a maximum of 2 inches of water is maintained in the oxygen mask.

INHALATION.—The pressure at the sensing line is lowered while breathing in, causing the pilot valve to open and oxygen to flow from the demand valve.

EXHALATION.—The pressure at the sensing line is increased while breathing out, causing the pilot valve to close; thus the pressure becomes equal on both sides of the demand valve diaphragm, causing it to close. Breathing out is accomplished through the A-13A oxygen mask exhalation valve.

PRESSURE BREATHING.—The pressure breathing control chamber consists of an aneroid mechanism, preset to begin expanding at approxmately 35,000 feet, and to supply the correct positive pressure in the pressure breathing oxygen mask, as ambient conditions change. The evacuated aneroid is calibrated to expand and exert a force on the pilot valve levers. This supplies oxygen at the positive pressure required or an individual at the various increasing altiudes. The regulator operation in the pressure breathing range is the same as that described under "Safety Pressure." The additional aneroid force causes the required pressure at the outlet of the regulator. The aneroid assembly ontains an aneroid stop spring that is calibrated o compress when the regulator pressure exeeds 18 inches of water or 50,000 feet altitude. Then, further expansion of the aneroid does not increase pressure. By this operation, pressures re maintained in the oxygen mask for the altiudes shown in table 10-2, at ambient flows of 0 l.p.m.

Table 10-2.—Specified altitudes and the minimum and maximum mask pressure in inches of water.

Pressure altitude in feet	Mask pressure inches of water	
	Minimum	Maximum
35,000		3.5
39,000		8.0
41,000	4.0	10.2
43,000	10.0	12.5

Bench Testing Type 29211 B-1 and C-1 Regulators

The type 29211 B-1 and C-1 regulators are SEALED at the factory and SHOULD NOT BE TAKEN APART for repair. By separate correspondence, COMNAVAIRPAC, COMNAVAIRLANT and CNATRA will designate activities authorized to adjust the pressure breathing aneroid and replace inlet screens.

The regulators must be subjected to the following tests every 60 days; however, no regulator should be rejected for failure to meet specified performance until OTS-565 test stand is modified by a miniature regulator test stand modification kit, P/N MA 20163. This kit is to be supplied by the Bureau of Naval Weapons Fleet Readiness Representative, Western District.

AUTOMATIC SAFETY PRESSURE TEST.—Set the oxygen inlet pressure at 50 p.s.i. on the pressure gage located within the altitude chamber (modification kit, P/N MA 20163). Record the pressures indicated on the pressure-suction manometer for regulator outlet flows of 0, 10, and 100 ambient liters per minute at sea level, 10,000, 20,000 and 30,000 feet, using valve A and B as chamber dive and climb valves, respectively, and valve C as the regulator outlet flow control valve.

Repeat the above test with the oxygen inlet pressure set at 90 p.s.i. on the oxygen pressure gage located within the altitude chamber. The recorded pressures for these tests must not go negative nor exceed 2 inches of positive water pressure.

AUTOMATIC POSITIVE PRESSURE BREATHING TEST.—Set the oxygen inlet pressure on the oxygen gage within the altitude chamber at 50 p.s.i. With a flow of 10 liters per minute, vary the altitude from sea level to 43,000 feet. Record the altitude at which the automatic positive pressure breathing device cuts in. This point will be evident when the pressure-suction manometer reading increases rapidly. The cut-in point must not exceed 39,000 feet. Vary the altitude between 35,000 and 43,000 feet and record the outlet pressures indicated on the pressure-suction manometer at each altitude in table 10-2, using a flow of 10 ambient liters per minute and 100 ambient liters per minute.

Repeat the above test with the oxygen inlet pressure set at 90 p.s.i. on the oxygen gage within the altitude chamber. The recorded pressures must be within the limits of table 10-2. The difference in recorded outlet pressures at 50 p.s.i. and 90 p.s.i. inlet for flows of 10 and 100 ambient l.p.m. at each altitude must not exceed 0.75 inches of water.

MAXIMUM PRESSURE CONTROL TEST.—Set the oxygen inlet pressure on the oxygen gage within the altitude chamber at 70 p.s.i. With an ambient flow of 10 l.p.m. evacuate the chamber to 50,000 feet altitude. Record the outlet pressures at 0 and 10 ambient liters per minute from the pressure-suction manometer. The maximum pressure control point will be evident when the pressure-suction manometer indicates a constant outlet pressure. The maximum pressure control must operate at 16 ± 2 inches of water at 50,000 feet.

VIBRATORY CONTROL.—If the regulator flutters during any of the tests, open the compensating chamber valve (modification kit P/N MA 20163) until flutter is eliminated. If flutter cannot be eliminated, the regulator is unacceptable. A flutter or vibration is defined as that condition in the system that causes the output flow and pressure-suction manometers to fluctuate.

ROBERTSHAW-FULTON 226-20004 MINIATURE REGULATOR

Description

The type 226-20004 miniature regulator is mounted on the body for both use in flight and bail out or emergency. It is so designed that with an inlet pressure of 40 to 90 p.s.i., it will deliver 100 percent oxygen automatically to the user between the altitudes of 0 to 50,000 feet. The regulator incorporates automatic safety pressure buildup to a maximum of 2 inches of water below 35,000 feet and automatic pressure breathing for altitudes above 35,000 feet. It integrates with the A-13A oxygen breathing mask. The assembly weighs 2.3 ounces and is about 2 5/8 inches in length and 2 5/8 inches in width, including inlet port.

The 226-20004 regulator consists of a demand actuating paddle, sensing diaphragm, demand valve diaphragm, safety pressure spring, pressure breathing aneroid, aneroid vent, aneroid chamber, and relief valve, as shown in figure 10-7.

Operation

Operating pressure is sent through the inlet port to the demand valve diaphragm. A small passage from the inlet line sends this pressure to the backside of the diaphragm as well; thus. the demand valve diaphragm is pressure balanced, but an area advantage on the backside of the diaphragm gives a positive sealing force.

Negative pressure caused by breathing in passes through the centrally located passageway shown by dashed lines on the cavity containing the sensing diaphragm. This vacuum causes the sensing diaphragm to tilt downward, pushing down the demand actuating paddle. As the paddle is forced downward, its base will be lifted from a seat which seals a second passageway from the backside of the demand valve diaphragm.

Raising the paddle base allows flow from this area. This causes a pressure drop behind the demand valve diaphragm and allows inlet pressure to lift the diaphragm from its seat permitting flow from the inlet source. Safety pressure is obtained by the safety pressure spring which will deflect the sensing diaphragm, causing flow through the unit until the force created by mask pressure equals the force of the safety pressure spring. This returns the sensing diaphragm to a balanced condition.

Automatic pressure breathing is obtained by diverting a small volume bleed from the inlet passage to the aneroid chamber. This bleed is normally vented from the aneroid cavity past the area labeled aneroid vent.

At the altitude at which automatic pressure breathing is to begin, the lip of the aneroid comes in contact with the seat, closing off the aneroid vent and building up the pressure which is sent directly to the sensing diaphragm. This pressure also lifts the sensing diaphragm, causing flow until mask pressures exert a force on the sensing diaphragm equal to the force exerted by pressure buildup in the aneroid chamber.

The relief valve on the unit acts as a pilot device to open the exhalation valve of the mask. This is accomplished by isolating the pressure pickup of the exhalation valve with the tube in the outlet port of the unit so that the exhalation

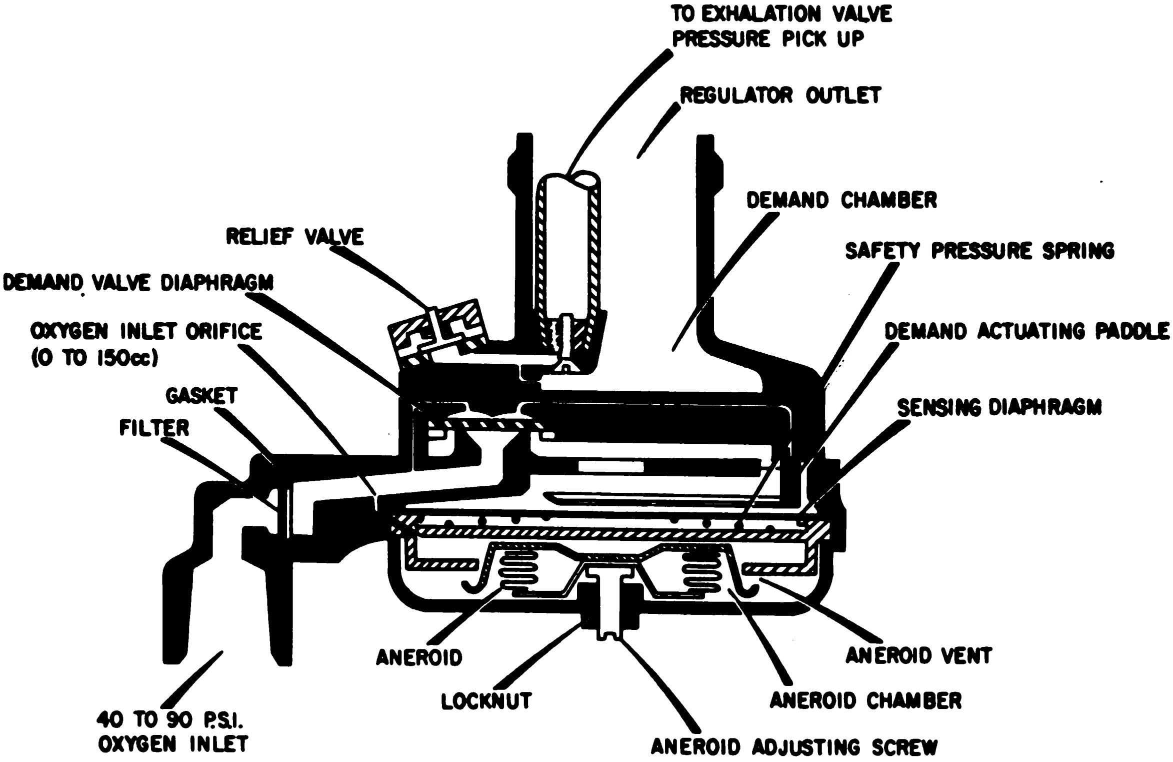


Figure 10-7.—The type 226-20004 oxygen regulator.

valve is compensated only by the pressure sent to it by the exhalation valve pickup tube.

Testing

AUTOMATIC SAFETY PRESSURE TEST.—Set up the regulator as shown in the instruction sheet included in the miniature regulator modi-ication kit, P/N MA 20163. Make sure the regulator outlet and piezometer-restrictor are one inch apart. Remove the rubber tube from he outlet of the regulator and cap the pressure pickup for testing.

Set the oxygen inlet pressure at 50 p.s.i. on he pressure gage located within the altitude hamber. Record the pressure indicated on the pressure-suction manometer for regulator out-et flows of 0, 10, and 100 ambient liters per minute at sea level, 10,000, 20,000 and 30,000 eet, using valves A and B as chamber dive nd climb valves, respectively, and valve C as he regulator outlet flow control valve.

Repeat the above test with the oxygen inlet pressure set at 90 p.s.i. on the oxygen pressure gage located within the altitude chamber. The ecorded pressures for the above tests must not go negative nor exceed 2 inches of positive water pressure.

AUTOMATIC POSITIVE PRESSURE BREATHING TEST.—Set the oxygen inlet pressure on the oxygen gage within the altitude chamber at 50 p.s.i. With a flow of 10 ambient liters per minute, vary the altitude from sea level to 43,000 feet. Record the altitude at which the automatic positive pressure breathing device cuts in. This point will be evident when the pressure-suction manometer reading increases rapidly. The cut-in point must not exceed 39,000 feet.

Vary the altitude between 35,000 and 43,000 feet, and record the outlet pressures indicated on the pressure-suction manometer at each altitude, as shown in table 10-2, using a flow of 10 ambient liters per minute and 100 ambient liters per minute.

Repeat the above test with the oxygen inlet pressure set at 90 p.s.i. on the oxygen gage within the altitude chamber. The recorded pressures must be within the limits of table 10-2. The difference in recorded outlet pressures at 50 p.s.i. and 90 p.s.i. inlet for flows of 10 and 100 ambient liters per minute at each altitude must not exceed 0.75 inches of water.

NOTE: DO NOT EVACUATE CHAMBER ABOVE 43,000 FEET, BECAUSE MAXIMUM PRESSURE CONTROL DEVICE ONLY CAN FUNCTION WHEN ATTACHED TO THE EXHALATION VALVE IN THE MASK.

MAXIMUM PRESSURE CONTROL TEST.—Remove the exhalation valve pressure pickup rubber tubing and set up the regulator as shown in figure 10-8. Set the oxygen inlet pressure at 50 p.s.i. Deliver a flow of 0.2 l.p.m. Make sure the rubber stopper seals the regulator outlet. Record the pressure at which the relief valve pops off. The popoff pressure must not exceed 18 inches of water. Lower the flow to 0.02 l.p.m. The pressure must not drop below 11 inches of water.

VIBRATORY CONTROL.—If during any of these tests the regulator flutters, open the compensating chamber valve until flutter is eliminated. If flutter cannot be eliminated, the regulator is unacceptable.

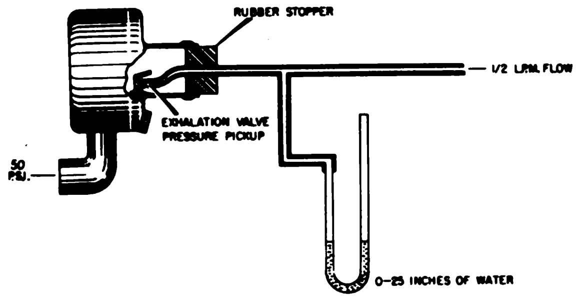


Figure 10-8.—Maximum pressure control test for type 226-20004 regulator.

F2700-1 FIREWEL REGULATOR

The F2700 (Firewel) oxygen breathing regulator is personnel mounted and is used both in the inflight and bailout or emergency conditions. The regulator is designed so that with an inlet pressure of 40 to 90 p.s.i. it will deliver 100 percent oxygen automatically to the user between the altitudes of 0 to 50,000 feet. The regulator incorporates an automatic safety pressure of two inches of water maximum below 35,000 feet, and automatic pressure breathing for altitudes above 35,000 feet. It is designed to integrate with the A-13A oxygen breathing mask. The regulator will maintain a safety pressure of 0 to 2 inches of water for ambient flows of 0 to 100 l.p.m. at inlet pressures of 50 to 90 p.s.i. At a 40 p.s.i. inlet pressure the regulator will maintain the required safety pressure for ambient flows from 0 to 70 l.p.m. The regulator weighs 2.5 ounces, is 2.5 inches long and 1.5 inches wide.

Operation

An unbalance of pressure on either side of the demand diaphragm will cause the diaphragm to move in the direction of the lowest pressure. The force of the safety pressure spring on the demand diaphragm causes a displacement in the direction of the demand chamber. Motion in this direction causes actuation of the tilt valve, thereby admitting oxygen from the 40 to 90 p.s.i. source to the regulator outlet and, consequently, to the A-13A oxygen mask. When the force on the demand chamber side of the diaphragm is equal to the force on the aneroid side of the diaphragm (due to the safety pressure spring) the diaphragm becomes balanced and the tilt valve is in equilibrium. By this action a safety pressure of a maximum of 2 inches of water is maintained in the oxygen mask.

PRESSURE CONTROL VALVE.—Oxygen from the inlet enters the orifice assembly and is monitored by the pressure control valve. This maintains the exhalation valve in equilibrium by loading 1.5 to 1.8 inches of water to counterbalance the effect of the safety pressure in the mask, thereby preventing the exhalation valve from dumping. This valve will sense tilt-valve leakage and will maintain the exhalation valve in equilibrium with the increased pressure in the mask. This will regulate any need for forced exhalation by the user.

INHALATION.—The decrease in pressur in the demand chamber due to inhalation cause a motion of the demand diaphragm in the direction of the demand chamber, thereby actuati the tilt valve and consequently allowing th oxygen required for inhalation to pass into th A-13A oxygen mask.

EXHALATION.—The increase in pressure i the demand chamber due to exhalation causes motion of the demand diaphragm in the directio of the aneroid chamber, thereby allowing th tilt valve to come to equilibrium so that exhalation can be accomplished through the A-13 oxygen mask exhalation valve.

PRESSURE BREATHING.—The aneroid or pressure breathing control chamber consists of an aneroid preset to start expanding at approximately 35,000 feet, an oxygen inlet bleed orifice, an aneroid vent outlet, and a relief valve. Oxygen is continually transmitted from the 40 to 90 p.s.i. oxygen source through the oxygen inlet bleed orifice to the aneroid chamber and exhausted to the ambient through the aneroid vent outlet. Since the oxygen flow through the bleed orifice is minute, and since this oxygen is continually exhausted to the ambient atmosphere, the aneroid chamber remains at essentially ambient pressures. However, as pressure breathing altitudes are approached, the aneroid expands and gradually closes the aneroid vent outlet, thus increasing the pressure maintained in the aneroid chamber and consequently back loading the aneroid side of the demand diaphragm with this same pressure. The unbalance of the diaphragm causes motion of the diaphragm in the direction of the demand chamber, thereby actuating the tilt valve and. consequently, allowing oxygen to flow into the oxygen mask. When the force on the demand chamber side of the diaphragm (due to mask pressure) is equal to the force on the aneroid side of the diaphragm (due to aneroid chamber pressure) the diaphragm becomes balanced and the tilt valve goes into an equilibrium position. By this action, the pressures are maintained in the oxygen mask for the altitudes shown in table 10-3 at ambient flows of 10 l.p.m.

Table 10-3.—Mask pressures for F2700 regulators.

Altitude in feet	Mask pressures (inches of water)	
	Min.	Max.
39,000	0	8.0
41,000	4	10.2
43,000	10	12.5
50,000	14	18.0

At 50,000 feet (and above) the mask pressure must not be greater than 18 inches of water. This pressure is controlled by the relief valve.

Bench Testing F2700 Regulators

The type F2700 regulator is sealed at the factory and should not be taken apart for repair. COMNAVAIRPAC, COMNAVAIRLANT, and CNATRA will designate activities authorized to adjust the pressure breathing aneroid and replace inlet screens.

The regulators must be subjected to the following tests every 60 days:

Automatic safety pressure test.
Automatic positive pressure breathing.
Maximum pressure control.
Vibratory control.

Instructions for performing the above tests are contained in *Aviation Clothing and Survival Equipment Bulletin* No. 6-61.

NOTE: No regulator should be rejected for failure to meet the specified performance until the OTS 565 test stand is modified by a miniature regulator test stand modification kit, P/N MA 20163.

LIQUID OXYGEN REGULATOR, TYPE MD-1

Description

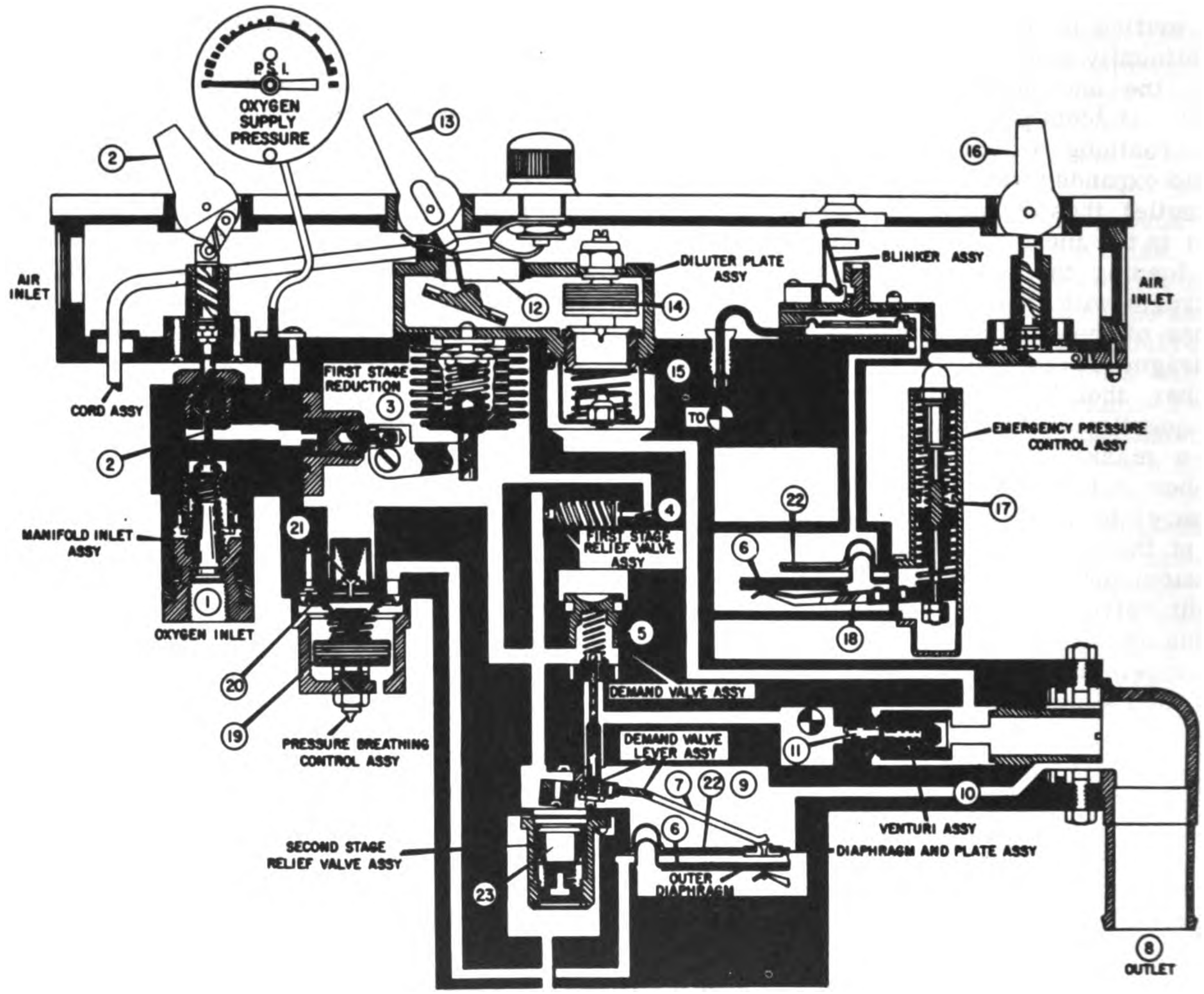
The MD-1 regulator is designed for use with pressure type masks to provide the correct oxygen and air mixture in the correct ratio (depending on altitude) and deliver this mixture at the correct oxygen pressure to the mask upon inhalation. With a tight mask and the diluter control lever in the NORMAL OXYGEN position, the regulator provides correct breathing mixtures at altitudes up to 43,000 feet for normal use and for short periods up to 50,000 feet during emergencies. The operating pressure ranges from 50 to 500 p.s.i.

The regulator weighs approximately 2.85 pounds; is 4 7/32 inches long, 5 3/4 inches wide, and 3 inches high; and installs in a mounting panel using conventional Dzus fasteners.

Operation

All controls and indicators necessary for indication of performance and control of operation of the MD-1 regulator are placed on an illuminated panel with the regulating components of the unit attached to the mounting plate and controls assembly. General characteristics and performance for which the equipment is designed are illustrated in figure 10-9 and are described as follows: Supply oxygen entering through inlet at (1) is filtered and passes through the manifold inlet assembly into the first stage reduction chamber (3) by the action of inlet supply valve (2). The pressure of the flowing oxygen is registered on the oxygen supply pressure gage. Chamber (3) is provided with the first stage relief valve assembly (4) to protect the regulator against overpressures.

Demand valve assembly (5) is opened when the pressure differential across the demand outer diaphragm (6) forces down the demand valve lever assembly (7). The pressure differential exists during the inhalation cycle of



1. Inlet
2. Inlet supply valve.
3. Reduction chamber.
4. Relief valve.
5. Demand valve.
6. Diaphragm.
7. Demand valve lever.
8. Outlet.
9. Demand diaphragm chamber.
10. Sensing port.
11. Venturi assembly.
12. Inlet port.
13. Diluter control lever.
14. Diluter aneroid.
15. Check valve.
16. Emergency pressure control lever.
17. Test spring.
18. Control lever.
19. Aneroid.
20. Diaphragm.
21. Pressure breather valve.
22. Plate assembly.
23. Relief valve.

Figure 10-9.—Regulator operation drawing.

the user by creating a reduction in the pressure outlet (8). Reductions in pressure at outlet (8) are sensed in the demand diaphragm chamber (9) through sensing port (10).

During periods of flow, the oxygen passes through the venturi assembly (11). At the venturi assembly the flow of oxygen mixes with ambient air which enters the regulator through inlet ports (12). The addition of ambient air to oxygen is controlled by the manual diluter control lever (13) and by the diluter aneroid assembly (14) which automatically produces a 100 percent oxygen concentration at altitudes above 32,000 feet.

Aneroid check valve assembly (15) prevents a flow of oxygen out through inlet ports (12). Emergency pressure control lever (16) applies force to the emergency pressure control test spring (17) which mechanically loads the outer diaphragm (6) through the control lever and center assembly (18). Mechanical loading of the outer diaphragm (6) provides positive pressure at the regulator outlet.

Automatic pressure and pressure breathing at altitudes above 30,000 feet are provided through pneumatic actuation of the aneroid assembly (19). This function begins at near 27,000 feet altitude. The force exerted on the diaphragm assembly (20) by the aneroid assembly actuates the pressure breather valve assembly (21) and oxygen flows to the diaphragm and plate assembly (22). The diaphragm and plate assembly is pressure loaded by this volume of oxygen actuating on the demand valve lever assembly (7) to the extent that positive pressure is built up at outlet (8) as the altitude is increased. Additional safety is obtained through the inclusion of the second stage relief valve assembly (23) in the regulator.

Operation Instructions

GENERAL.—Every crewmember should know the exact location and use of the regulator at his station. The oxygen mask hose is connected to the coupling end of the breathing hose installed on the outlet of the regulator. The breathing hose clip is then attached to the parachute harness or clothing to permit freedom of motion.

NORMAL OPERATION.—The following procedure must be followed prior to flights requiring the use of oxygen equipment for breathing. Place the pressure breathing control lever (fig. 10-10) in the SUPPLY ON position. Place the diluter control lever in the NORMAL OXYGEN position. Connect the oxygen mask hose to the quick connect, place mask to face, and check out function of the mask in the prescribed manner.

While at ground level, the regulator will not normally supply oxygen from the supply system to the mask. The emergency pressure control lever must therefore be used in order

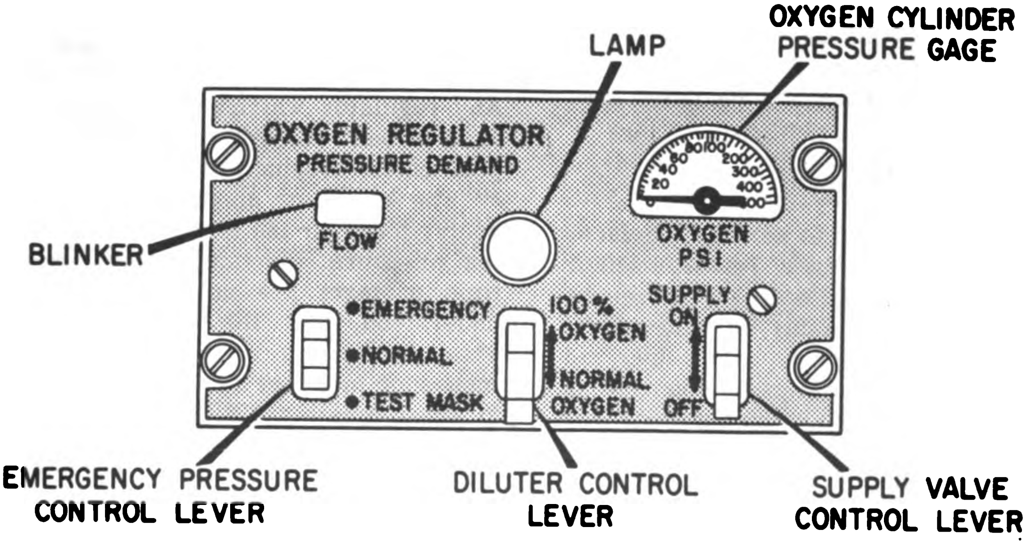


Figure 10-10.—Regulator operating controls and indicators.

to check out the oxygen supply function of the regulator at low altitudes. The emergency control lever is spring loaded in the TEST MASK position and will return to NORMAL position under typical operating conditions.

ABNORMAL OPERATION.—Place the diluter control lever in the 100% OXYGEN position if existence of carbon monoxide or smoke, or other poisonous or irritating gases are suspected in the area. This procedure shuts out the ambient air. This checkout of the regulator may be used at all altitudes.

EMERGENCY OPERATION.—Switch emergency pressure control lever to EMERGENCY position when evidences of inadequate oxygen supply are present. When in the EMERGENCY position, the regulator delivers 100 percent oxygen to the user, at a positive safety pressure.

INFLIGHT CHECK.—Each crewmember should make a periodic check of the regulator at his station during flight, and report or remedy any of the following as applicable:

1. Any symptoms of lack of oxygen or other illness.
2. Any improper positioning of a control lever.
3. Leaks in any tubing or connections.
4. Low or improper reading on oxygen cylinder.
5. Failure of blinker to indicate FLOW.

EQUIPMENT SHUTDOWN.—The equipment shutdown is performed as follows:

1. Switch pressure breathing control lever to the SUPPLY OFF position.
2. Remove mask from the face and disconnect oxygen mask hose at the quick disconnect coupling.

Maintenance

Maintenance is limited to service, replacement, adjustment, and minor repair. Minor repair is confined to that work which can be performed without disassembly, or with partial disassembly of the equipment which does not require the use of specialized shop testing and calibration equipment. Instructions for major repairs and for disassembly requiring the use of specialized shop testing and calibration equipment are covered in the *Overhaul Instruction Manual* (NA 03-50GDA-502), and such work is performed by specialized overhaul shops engaged in such work.

Personnel assigned to perform maintenance operations on the equipment are cautioned to become thoroughly familiar with the functions and physical components of the equipment by a careful and complete study of the information contained in the Overhaul Instruction Manual.

PARTS REPLACEMENT.—If a malfunction in a component part other than the lamp occurs, the regulator should be removed from the aircraft. Replacement of parts is limited to the replacing of a faulty lamp. Do not attempt to repair or replace any other parts of the regulator.

PERIODIC INSPECTION.—Table 10-4 outlines the various inspections for the regulator.

MINOR REPAIRS.—Minor repairs are limited to checking the security of components. Tighten any loose connections, screws, or bolts. Loose cable connections should be resoldered.

CLEANING.—Cleaning of the equipment consists of wiping off the regulator with a clean, dry, lint-free cloth. Make certain that the plastic lighting plate is free of dirt so legibility of markings and visibility of indicators are not impaired. Pay particular attention to condition of screened inlets in the sides of the regulator housing.

TROUBLESHOOTING.—Troubleshooting information for the regulator is shown in table 10-5.

Test Procedures

The tests contained in this section are to be performed under bench test conditions, utilizing OT-198-1 and OT-201 test stands. Any regulator which fails to meet these tests should be returned to facilities capable of performing overhaul operations on the regulator.

The regulator should be mounted in a horizontal plane in the test stand OT-198-1. When the pressure and temperature existing at the time of tests are not specified, it should be understood that the test will be made at atmospheric pressure of approximately 29.92 inches of mercury and at a room temperature of approximately 77° F. When tests are made with atmospheric pressure or room temperature differing materially from the above values, proper allowances must be made for the differences from the specified condition except that all outlet flows must be measured at approximately 77° F. and ambient pressure. The

Table 10-4.—Periodic inspection of MD-1 regulator.

Component	Nature of inspection	Inspection time
Plastic lighting plate	Visual check for faulty markings, cracks, or discoloration.	*120 hours
Lamp	Visually check electrical performance.	Preflight
Cord assembly	Visually check electrical insulation and contact.	*120 hours
Outlet	Visually check for secure attachment and correct positioning.	*120 hours
Housing	Visually check for cracks.	*120 hours
Connecting point and gage reading	Visually check for indication of leakage.	Preflight
**Inlet port screen	Visually check for evidence of dirt and obstruction.	*120 hours
Panel assembly	Visually check legibility of markings.	Preflight

*Or as established in existing directives.

**Presence of an unduly large amount of dirt or dust on screens is an indication that regulator should be removed and thoroughly cleaned.

inlet pressure should be adjusted to 150 p.s.i. during all tests except when otherwise specified.

EMERGENCY PRESSURE TEST.—The emergency pressure test is performed as follows:

1. Place the supply lever on the regulator in the ON position.
2. Apply a pressure of 150 p.s.i. to the regulator inlet. Note the pressure at the outlet.
3. Place the emergency lever in the EMERGENCY position.
4. Adjust the test stand for a flow of 10 liters per minute from the regulator. The pressure at the outlet of the regulator should be 3.5 ± 0.5 inches of water as indicated by the test stand.
5. Adjust test stand for a flow of 80 liters per minute.
6. Place the diluter lever in the 100% OXYGEN position. The pressure at the outlet should not be less than 2.0 inches of water.
7. Adjust the test stand for a flow of 10 liters per minute.
8. Place the emergency lever in the TEST MASK position. The regulator should deliver an outlet pressure in the range of 6 to 16 inches of water as indicated by the test stand.

FLOW SUCTION TEST.—Place the supply lever in the ON position. Adjust inlet pressures to the regulator as specified in table 10-6. The flows indicated in table 10-6 must be drawn from the regulator. Set the diluter lever on the regulator successively at NORMAL OXYGEN and 100% OXYGEN. At ground level with either increasing or decreasing flows, the suctions required to produce the flows given in table 10-6 should not exceed the suction values given in table 10-6. After suction is reduced to zero, the flows should not exceed 0.01 liter per minute.

NOTE: All measurements of the outlet suction pressure must be made directly at the outlet of the regulator.

Table 10-5.—Troubleshooting.

Trouble	Probable cause	Correction
Oxygen cylinder pressure gage fails to indicate proper pressure with fully charged pressure source.	Defective gage. Blocked or leaking supply line. Defective manifold inlet assembly.	Replace regulator. Replace or clean supply line to regulator. Replace regulator.
Oxygen not available at mask with proper source to regulator and other than "emergency" setting on regulator.	Regulator controls improperly positioned. Hose to mask is kinked. Regulator not functioning properly.	Correct position of controls. Straighten hose and reposition outlet. Replace regulator.
Oxygen not available at mask with proper pressure source to regulator and regulator control set at "emergency".	Kink or other malfunction between hose and mask. Faulty linkage from emergency pressure control lever.	Replace or readjust equipment as necessary. Replace regulator.
Oxygen available at mask but flow is not indicated.	Defective blinker assembly.	Replace regulator.
Gage pressure drops when regulator is not in use.	Loose or leaking connections. Defective manifold.	Tighten or replace connections as necessary.
Improper mixture of air to oxygen.	Defective regulator.	Replace regulator.
Panel light fails to light.	Burned out lamp. Faulty light assembly. Faulty electrical hookup to power source.	Replace lamp. Replace regulator. Repair electrical hookup.

SAFETY PRESSURE AND PRESSURE BREATHING TEST.—This test is performed as follows:

1. Place the supply lever in the ON position.
2. Adjust inlet pressure to the regulator at 150 p.s.i.
3. Place the diluter lever in the NORMAL OXYGEN position.

Table 10-6.—Suction flow characteristics.

Inlet pressure (p.s.i.)	Outlet flow (Liters per minute)	Maximum Outlet suction (Inches of water)
50	30	0.45
50	50	0.70
150	90	1.00

4. At the delivery pressures specified i column 1 of table 10-7 (corresponding to a particular flow) the regulator should be withi the altitude range specified in column 2 of the table.

OXYGEN RATIO TEST.—The oxygen ratio test is performed as follows:

1. Place the supply lever in the O position.
2. Adjust inlet pressure to the regulator at 150 p.s.i.
3. Place diluter lever in the NORMAL OXYGEN position.
4. The ratio (by volume) of cylinder oxyge delivered to the total gas delivered by the regulator at various altitudes should be as specifie in table 10-8.

OUTWARD LEAK TEST.—The outward lea test is performed as follows:

1. Place the supply lever in the OFF positio

Table 10-7.—Safety pressure and pressure breathing characteristics.

Outlet pressure for 10 liters per minute flow (inches of water)	Altitude range for Column 1 (mm of mercury)	Maximum outlet pressure increase for zero liters per minute (inches of water)	Maximum outlet pressure decrease for indicated flow (inches of water)
1.0	258.0 to 138.0	1.0	0.9 for 70 liters per minute
2.0	236.0 to 134.0	1.3	1.3 for 135 liters per minute
8.5	127.5 to 110.5	1.3	1.3 for 135 liters per minute
15.0	102.1 to 87.3	1.3	1.3 for 135 liters per minute

NOTE: The outlet pressure for the altitude range of 225.6 to 138 mm of mercury must not fall below 0.01 inch of water for a flow of 0 to 10 liters per minute. The outlet pressure for the altitude range of 87.3 to 138 mm of mercury must not fall below 0.01 inch of water for a flow of 0 to 70 liters per minute.

2. Apply a pressure of 17 inches of water to the regulator outlet through a flow measuring device. This 17 inches of water pressure should be maintained, and the flow necessary to maintain this pressure must not exceed 0.12 liter per minute. During this test the relief valve must not be covered since the allowable leakage through this valve at 17 inches of water is included in the given leakage value of 0.12 liter per minutes.

OUTLET LEAKAGE TEST.—Perform the outlet leakage test as follows:

1. Place the supply lever in the ON position.
2. Adjust inlet pressure to the regulator at 150 p.s.i.
3. Place a film of leak test compound across the outlet fitting of the regulator. The film should not advance more than 1/16 inch in 3 seconds.
4. Repeat the test 3 or 4 times to make certain the bubble is not increasing in size because of the temperature difference inside and outside the regulator.

FLOW INDICATOR TEST.—Perform the flow indicator test as follows:

1. Place the supply lever in the ON position.
2. Adjust the inlet pressure to the regulator at 150 p.s.i.
3. Place diluter lever in the NORMAL OXYGEN position.

NOTE: At sea level the flow indicator must be fully open at a flow of 20 liters per minute.

4. Place diluter lever in 100% OXYGEN position. (At sea level the flow indicator must be fully open at a flow of 8 liters per minute.)
5. With the test stand adjusted for an altitude sufficient to give 17 inches of water delivery pressure, the flow indicator should be fully open at an ambient flow of 12 liters per minute. When the flow is reduced to zero the flow indicator should close immediately.

INWARD LEAKAGE TEST.—The inward leakage test is performed as follows:

1. Place the supply lever in the OFF position.
2. Place the diluter lever in the 100% OXYGEN position.
3. Connect a flowmeter to the outlet of the regulator.
4. Apply a suction of 10 inches of water to the outlet through the flowmeter. The leakage must be less than 0.2 liter per minute.

RELIEF VALVE TEST.—The relief valve test is performed as follows:

1. Place the supply lever in the OFF position.
2. Place the diluter lever in the 100% OXYGEN position.
3. Apply a gradually increasing pressure to the outlet of the regulator.
4. The relief valve should vent 45 liters per minute at a pressure not greater than 3.0 inches of mercury. The relief valve must not leak in excess of 0.01 liter per minute at 17 inches of water pressure.

OXYGEN REGULATOR, TYPE MD-2

The MD-2 regulator is designed for use with pressure type masks and provides the

Table 10-8.—Oxygen ratio.

Altitude (feet)	Outlet flow (liters per minute)	Percent cylinder oxygen added.	
		Minimum	Maximum
10,000	15	6	35
10,000	50	6	35
10,000	85	6	35
15,000	5	14	100
15,000	15	14	42
15,000	50	14	42
20,000	15	24	55
20,000	50	24	55
20,000	85	24	65
25,000	5	40	100
25,000	15	40	80
25,000	50	40	80
32,000	85	98	100

oxygen and air mixture in the correct ratio (depending on altitude). The regulator delivers this mixture at the correct oxygen pressure to the mask upon inhalation. With a tight mask and the diluter control lever in the NORMAL OXYGEN position, the regulator provides correct breathing mixtures at altitudes up to 43,000 feet for normal use and for short periods up to 50,000 feet during emergencies. The MD-2 is identical in every respect to the MD-1 except for the operating pressure, which ranges from 50 to 2,000 p.s.i.

CHAPTER 11

OXYGEN COMPONENT TEST STANDS

Parachute Riggers are responsible for shop testing aircraft oxygen system components, including breathing regulators, liquid oxygen converters, and various types of control valves and other items. The AME is responsible for checking system components on the aircraft; however in case of malfunctioning, he removes the component from the aircraft and brings it to the oxygen shop where the PR determines the trouble. This is accomplished with the use of the various types of test equipment described in this chapter.

Regulator Test Stands

Regulator test stands are designed for testing oxygen breathing regulators for flow capacities, oxygen concentrations, and pressure characteristics at various simulated altitudes. Various leakage tests may also be performed. Coverage in this chapter is limited to the OTS-565 and OTS-566 series, since practically all of the older types of stands have been replaced with one of these types.

OTS-565 SERIES TEST STANDS

The OTS-565 series test stands are designed or testing various types of oxygen regulators nder simulated altitude conditions. By measurng the outlet suction or pressure for specified lows at different altitudes, as well as the ratio of air and oxygen delivered by the regulator, t is possible to determine whether or not the egulator performance conforms to service requirements. Provisions are also incorporated or making various leakage tests and the emergency flow test on regulators. These test stands can also be used for testing full pressure suit components; however, the earlier models must be modified, as described in chapter 6.

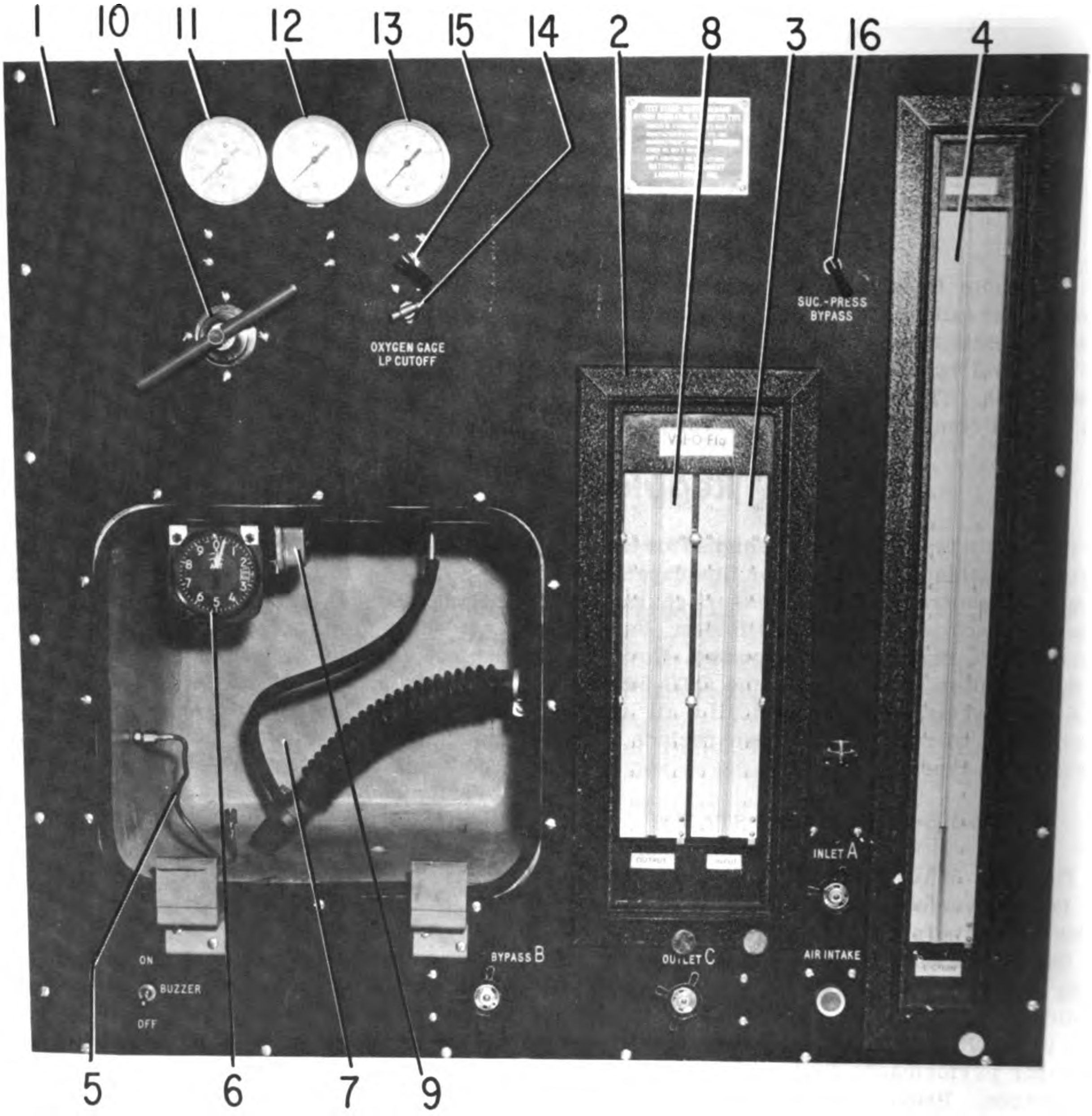
Aside from appearance, the principal diference between the OTS-565 and the earlier ypes of test stands is that the OTS-565 is quipped with Vol-O-Flo elements. The Vol-O-Flo elements are used to create the pressure rop necessary to actuate the Vol-O-Flow manometers, while earlier types were equipped with glass wool canisters designed for the same urpose. The OTS-565 is also different in that the complete test stand is calibrated in inches of water instead of liters per minute((l.p.m.).

Figures 11-1 and 11-2 illustrate the front and rear views of the equipment. The top cabinet consists of an altitude chamber, piping assemblies, control valves, Vol-O-Flo manometers, Vol-O-Flo elements, pressure-suction manometer, altimeter, and pressure gages. The lower cabinet contains a Gast vacuum pump directly coupled to a 1 hp. motor. Figure 11-3 illustrates the pump and motor assembly.

Principles of Operation

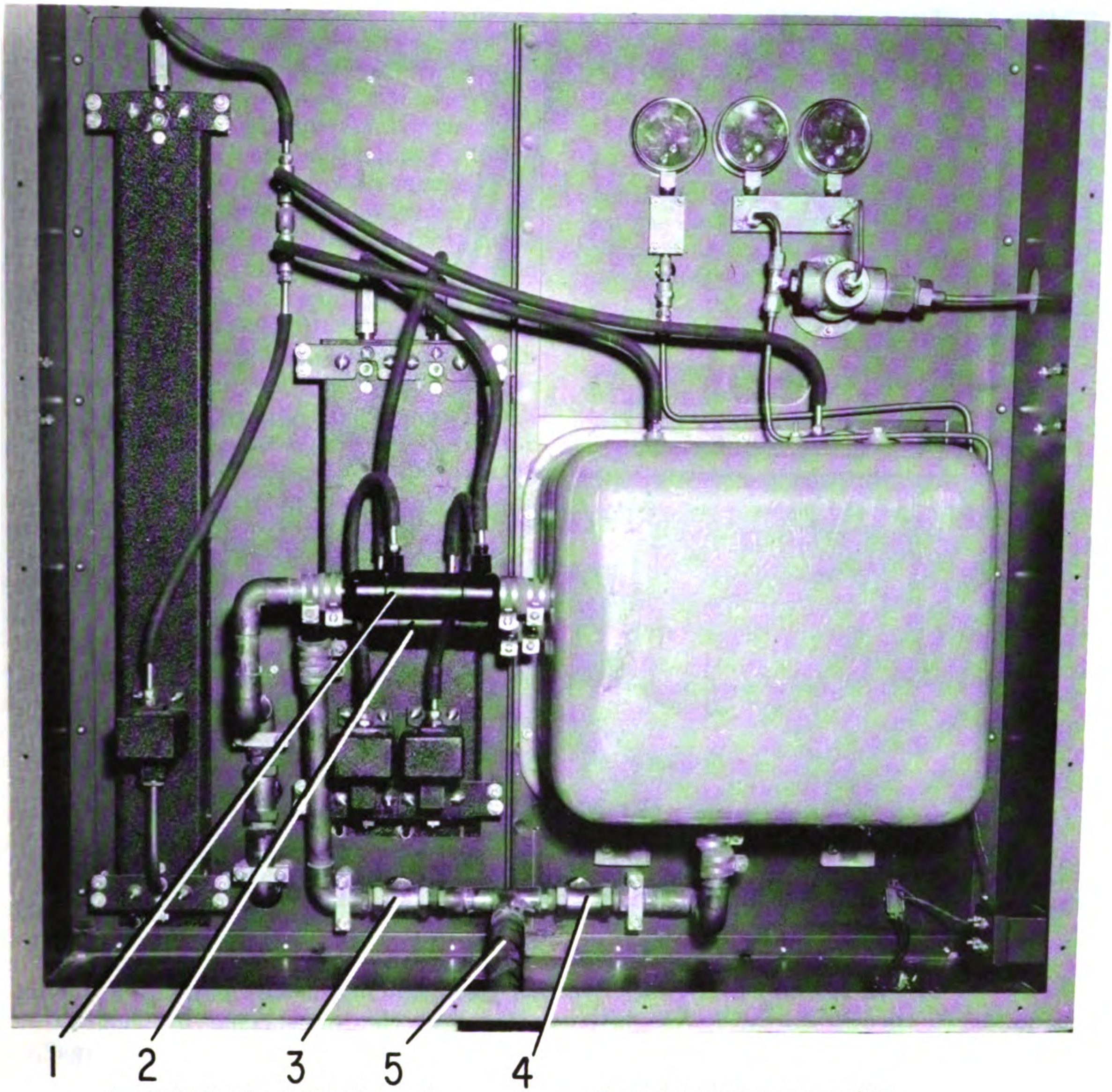
The OTS-565 test stand is suitable for testing demand, diluter demand, pressure breathing diluter demand, or the miniature pressure breathing demand oxygen regulators having outlet pressures of up to 20 inches of water. Flows are metered over the range of 0-150 l.p.m. Since the Vol-O-Flo manometers of the OTS-565 test stand are calibrated in linear inches of water, all liter-per-minute expressions or measurements must be converted to indicated inches of water through use of the output oxygen Vol-O-Flo element correction curves furnished with each test stand.

The Vol-O-Flo elements are designed to be as altitude independent as possible, but calibration charts are furnished for all altitudes and must be used. Using these Vol-O-Flo elements, the Vol-O-Flo manometers indicate the amount of air flowing into the chamber to provide the required dilution, and also measure



1. Case.
2. Panel.
3. Vol-O-Flo inlet manometer.
4. Pressure-suction manometer.
5. Oxygen inlet.
6. Altimeter.
7. Altimeter chamber.
8. Vol-O-Flo outlet manometer.
9. Buzzer.
10. Oxygen pressure reducer.
11. Cylinder pressure gage.
12. Regulator pressure gage, high pressure.
13. Regulator pressure gage, low pressure.
14. Oxygen cutoff valve.
15. Relief valve (bleed valve).
16. Pressure-suction bypass valve.

Figure 11-1.—Front view of OTS-565 test stand.



1. Vol-O-Flo inlet element.
2. Vol-O-Flo outlet element.
3. Inlet piping assembly.
4. Outlet-bypass piping assembly.
5. Vacuum outlet.

Figure 11-2.—Rear view of OTS-565 test stand.

e amount of air-oxygen mixture flowing out f the regulator.

The output valves and vacuum source provide flow demand on the oxygen regulator, which the uction controlled demand valve of the regulator ttempts to provide. The regulator outlet suction r pressure measured by the pressure-suction anometer indicates whether or not the suction controlled demand valve of the regulator is performing properly.

In a pressure breathing regulator, a pressure is provided from an additional loading in the regulator controlled by an aneroid element. The pressure breathing characteristics can thus be determined. This is done by evacuating the altitude chamber to the desired altitude by the

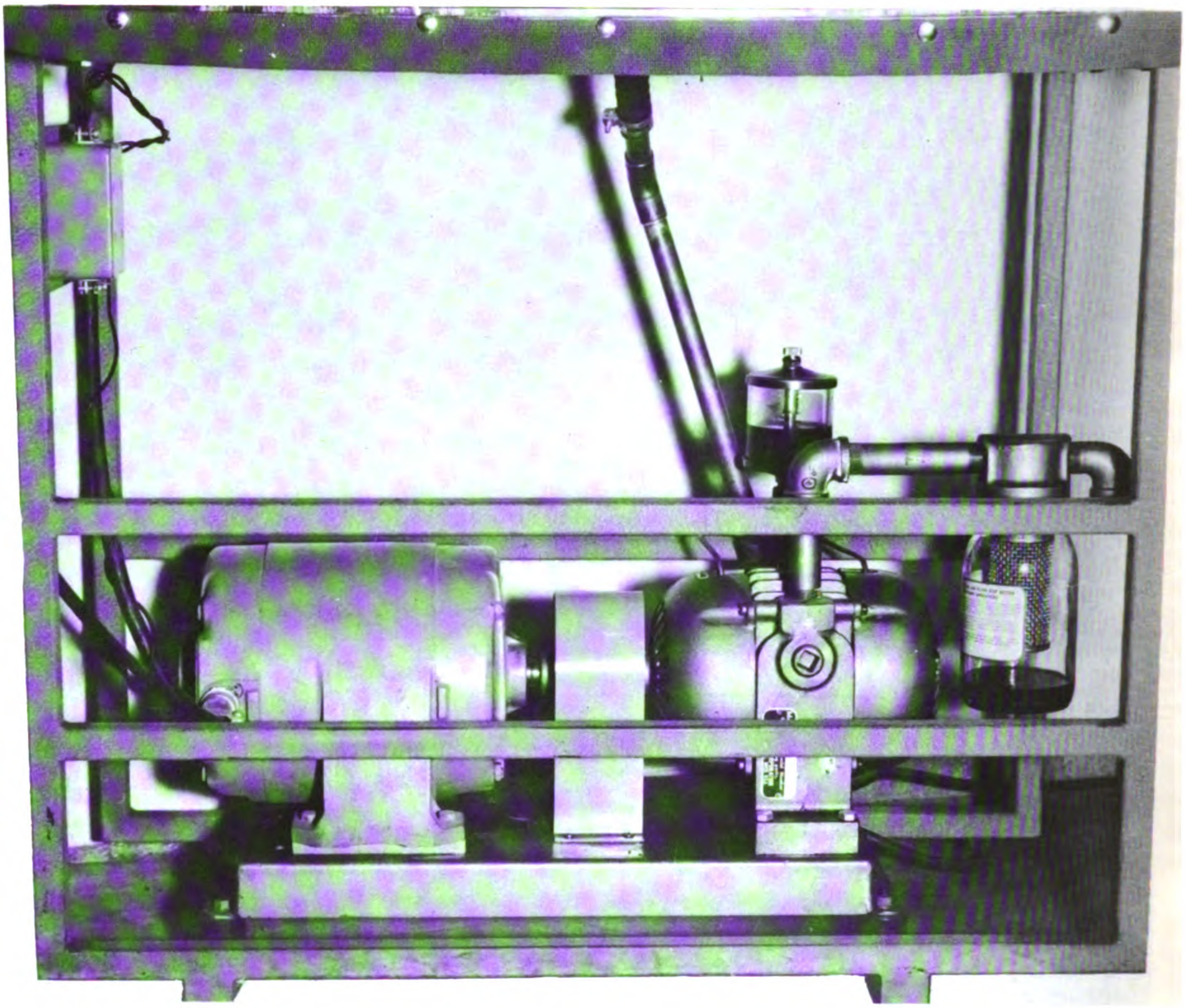


Figure 11-3.—Front view of vacuum pump and motor assembly.

use of the bypass valve while the outlet valve is cracked to permit a small flow (5 to 10 l.p.m.) through the regulator. This small flow must be allowed to prevent damage to the regulator. The output valves are then adjusted for various rates of flow, and suction or pressure is obtained from the indications of the output Vol-O-Flo manometer and the pressure-suction manometer.

In a diluter regulator, the flow passing through the regulator is not all oxygen, dilution air being drawn into the regulator from the chamber. The amount of dilution air is controlled by an aneroid. Through the input valves and input Vol-O-Flo element, air is admitted into the chamber to supply the air being removed by the diluter and thus maintains the desire test altitude in the chamber.

Description of Components

ALTITUDE CHAMBER.—An airtight chambe provides a space for simulating the variou test altitudes. The chamber is sealed by cover glass which rests in two brackets in fron of the chamber.

The altitude chamber has eight connections– a high-pressure oxygen inlet, an air inlet, tw chamber pressure taps, a regulator outlet pres-sure tap, a bypass outlet, a regulator outlet and an electrical connection.

One pressure chamber tap is connected to on side of the suction-pressure manometer. Th other is for connection to a barometer and is capped with a 1/8-inch pipe plug.

PIPING.—The piping consists of two major assemblies, an air inlet assembly which permits air controlled by the air inlet valve to enter the altitude chamber, and a regulator outlet-bypass assembly which permits evacuation of the regulator outlet through an outlet valve, or evacuation of the chamber through the bypass valve. The air inlet hole, which is covered with a fine screen, should never be blocked nor should dirt or dust be permitted near it.

CONTROL VALVES.—Three needle valves are used. One, in the air inlet assembly, permits air to be bled into the altitude chamber either to maintain a chamber altitude when the regulator is removing air from the chamber through its diluter, or to permit bringing the chamber back to atmospheric pressure from a simulated altitude. The other two valves are in the outlet-bypass assembly. The outlet valve controls the flow of air-oxygen leaving the regulator. The bypass valve permits independent evacuation of the altitude chamber. It is used only to evacuate the chamber to change altitudes above 30,000 feet, or in an emergency when the suction-pressure manometer has been overloaded. The inlet, bypass, and outlet valves are labeled respectively, A, B, and C on the panel.

PRESSURE REDUCER.—The pressure reducer supplied with the OTS-565 test stand is designed to regulate supply pressures up to 3,000 p.s.i. This is adequate for setting pressures for regulators designed to be tested with high supply pressures, but may damage regulators designed to operate on only 50 to 150 p.s.i. The difficulty of adjusting and maintaining this low pressure (50 to 150 p.s.i.) with a high-range pressure gage may result in overloading the oxygen regulator. Therefore, for testing of regulators requiring oxygen inputs of only 50 to 150 p.s.i., it is recommended that the test stand low-pressure cutoff valve be opened.

The cutoff valve is connected at the tee where it joins the low-range (200 p.s.i.) gage line. (See fig. 11-4.) Low oxygen inputs can be accurately set on the low-pressure gage without any danger of overloading the gage. At approximately 175 p.s.i. the relief (popoff and bleed) valve will dump excessive oxygen pressure. This relief valve can also be used to bleed the oxygen pressure in the lines after completion of the performance tests. The pressure set on the low-pressure gage (0-200) will also register on the high-pressure (0-3,000) gage, but due to the extremely high-pressure range of the gage, the needle will barely move off the peg.

NOTE: Liquid oxygen regulators should not be tested using this pressure reducer. An auxiliary pressure reducer should be installed at the oxygen inlet. For further instructions, refer to NavAer 17-15BC-505.

Figure 11-4 is a schematic diagram of the pressure reducer and the gage connections. When an adequate supply pressure is turned on, it will always register on the 0-4,000 p.s.i. cylinder pressure gage. Turning the pressure reducer handle clockwise supplies and increases the pressure delivered to the regulator (pigtail) and is registered on the high-pressure delivery gage. Extreme caution must be observed to assure the low-pressure gage cutoff valve is closed when setting pressures in excess of the range (0-200 p.s.i.) of the low-pressure gage.

VOL-O-FLO MANOMETERS.—Two Vol-O-Flo manometers are used in the test stand. Each Vol-O-Flo manometer consists of a Vol-O-Flo manometer element, from which the manometer is connected. One Vol-O-Flo manometer is in the air inlet line downstream from the air inlet valve. The other Vol-O-Flo manometer is in the regulator outlet line upstream from the outlet valve. The two Vol-O-Flo manometers are thus substantially at chamber pressure and are calibrated to give the flows at the ambient altitude (simulated chamber pressure altitude). The Vol-O-Flo manometers are of the linear type in which the pressure drop across the Vol-O-Flo element is directly proportional to the volumetric (ambient) flow. The Vol-O-Flo measuring manometers have a range of about 12 inches of water and are inscribed in linear inches.

In addition to the two Vol-O-Flo manometers there is one pressure-suction manometer located on the left side of the test stand. The pressure-suction manometer is calibrated from -4.0 to +20.0 inches of water. The pressure-suction manometer is designed to measure the pressure and suction required to draw a specified flow through the regulator. Excessive pressure or suction to the manometer is equalized by operating the pressure-suction bypass valve, located just above the altitude chamber. (See fig. 11-1, item 16.)

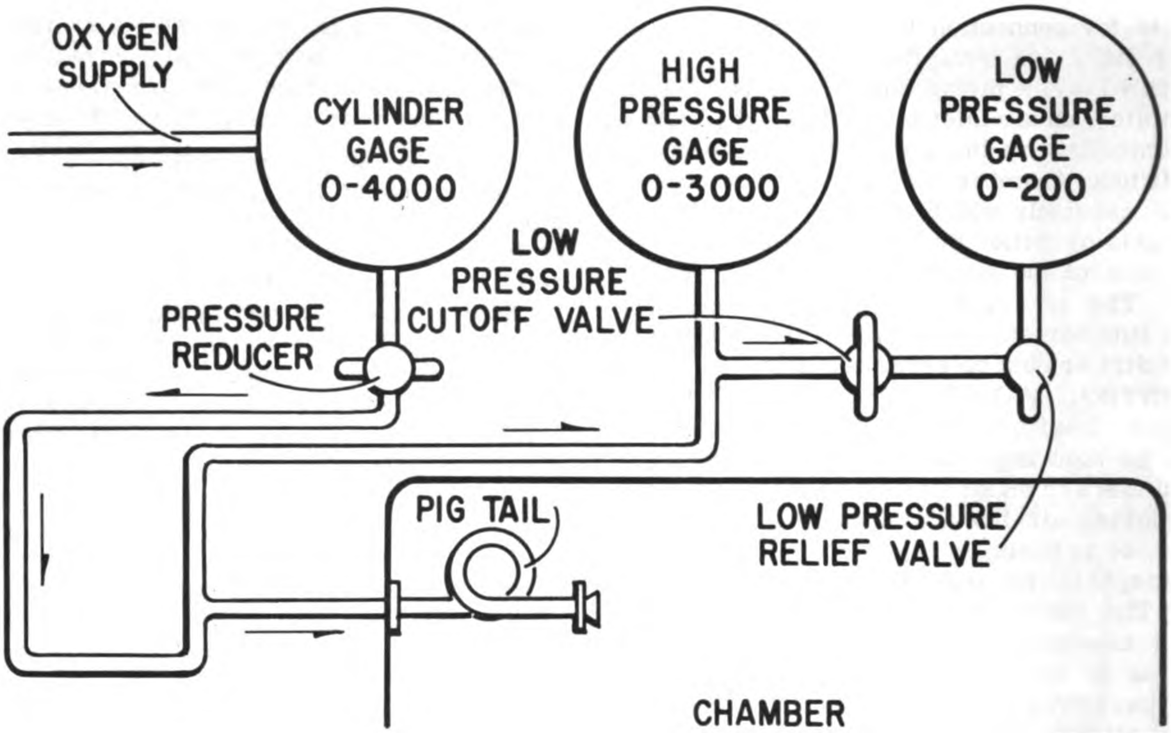


Figure 11-4.—Schematic diagram of pressure reducer and pressure gages for OTS-565 test stand.

Calibration Charts

Three copies of the calibration charts are supplied with each test stand. For testing diluter demand regulators, a table of test points (ratio performance chart) can be set up. This table can be computed from the Vol-O-Flo element calibration curves and the performance requirements for the regulator, published in the Service Instructions Manual for the regulator to be tested.

Once a table has been established for a particular regulator, the operator has no need to make any correction to the Vol-O-Flo manometer readings, other than for temperature variation. The calibration curves show that the ambient flow at any indication varies with gas composition and varies slightly with altitude. The input Vol-O-Flo element calibration depends only on altitude and temperature since only air is passing through the element. Similarly, the output Vol-O-Flo element calibration depends only on altitude and temperature when the regulator is operated with the diluter control turned off, in which case only oxygen is being passed. When the regulator is operated with the diluter control turned on, a variable air-oxygen mixture passes through the output Vol-O-Flo element.

TEMPERATURE CONSIDERATIONS.—On the linear type Vol-O-Flo element, the reading for a given flow is dependent on the gas (air, oxygen, or mixture), altitude, pressure, and temperature. The Vol-O-Flo elements are calibrated at the factor at a specified temperature usually 72° F. If the test stand is operated in the temperature range of 65° F. to 80° F., temperature corrections may usually be neglected.

If greater accuracy is required or if the test stand is used at temperatures outside this temperature range, a temperature correction may be applied as follows: Determine the temperature for which the test stand was calibrated. If the test stand was calibrated against a field standard calibrator, the temperature of calibration is that for which the field standard correction curves were made. For each degree Fahrenheit the test stand is operating above the calibration temperature, the reading will be too high by 0.15 percent. For each degree Fahrenheit below the calibration temperature, the Vol-O-Flo manometer reading will be 0.15 percent too low. These temperature corrections are in addition to and independent of corrections for altitude or gas mixture.

Preparation for Use

ASSEMBLY.—The OTS-565 test stand is shipped in two crates. The test stand proper is packed in one crate, and the pump stand is in the other. Particular attention should be given to careful uncrating to assure that none of the parts are damaged. The pump stand should be assembled first. Insert the oilcup on the top of the pump and tighten. Screw the glass jar in place over the exhaust muffler. Make up a 220-volt, 3-wire, single-phase a-c line, using the 3-prong plug provided. NOTE: Some test stands are being equipped with 220 volt, 3 phase a-c motors.

Connect the a-c line to a power source and start the pump. Be sure the pump is rotating in the right direction as indicated by the arrow. The pump should be given a quick check to see if it is producing good suction. This can be done by placing the hand over the rubber connecting tube, when the pump is in operation.

The test stand proper can now be assembled. After removing the back panel and the four mounting bolts, place the test stand on top of the pump stand, oriented so that the electrical connections are on one side and the pump inlet coincides with the chamber outlet connection. Bolt the test stand to the pump stand to make one unit. Connect the leads (buzzer connection) from the pump stand to the terminal provided in the test stand. Slip the vacuum-pump hose over the metal outlet tube of the test stand and tighten the clamps.

MANOMETERS.—Proper and initial adjustments of the manometers and other measuring components are simple but important. Much of the accuracy of the test stands depends upon careful setup procedures. To protect the pressure-suction glass manometer tube during shipment, cotton wads have been inserted between the scale and the glass tube. Do not attempt to move the scale adjustment knob in front of the manometer until this packing has been removed.

After the cotton packing has been removed, replace the manometer panel and scale adjustment knob, and position the scale so that it is near the center of its travel. Remove the Allen head screw from the top of the manometer wells and fill each manometer well with the King blue oil (Sp. Gr. 1.000) packed with the stand. The manometers should be filled to the zero level, using a suitable funnel. Replace the Allen head screws, using a suitable sealer such as glyptal. Care should be observed to avoid contaminating the manometer fluid.

OXYGEN LINE.—The high-pressure oxygen line is connected to the pressure reducer by passing the proper end through the hole in the side of the cabinet, after which the free end is connected to an oxygen supply source.

BUZZER AND ALTIMETER.—The operation of the buzzer is checked by simply throwing the switch, which is located at the lower left-hand corner. The altimeter index is adjusted to read 29.92 inches of mercury. If there is any doubt as to the accuracy of the altimeter, it should be checked against a master altimeter of known accuracy.

LEVELING.—The level of the test stand is checked by observing the bubble level on the stand. The manometer scales can be adjusted to zero readings by using the knobs provided at the bottom of each manometer.

ADJUSTMENTS.—After all the preliminary assembly steps have been taken and the cover glass has been unwrapped, examined, and set aside for appropriate use, the stand is ready for leakage tests which are conducted before the apparatus is used. The high-pressure oxygen system can be tested for leaks before the chamber is evacuated. This is accomplished as follows:

1. Remove the oxygen inlet pigtail from the elbow fitting and cap with an AN 820 flared tube fitting.
2. Turn on the oxygen supply valve.
3. With the oxygen low-pressure gage cutoff valve closed, adjust the output from the oxygen pressure reducer (clockwise) to 500 p.s.i. The cylinder pressure should be above 1,800 p.s.i.
4. Turn off the oxygen supply valve.
5. Note the rate at which the pressure on the high-pressure delivery gage drops. If the pressure does not drop more than 50 p.s.i. in 30 minutes, the high-pressure inlet system is adequately leaktight; if the leak is excessive, check the leakage at the various joints involved

and tighten where necessary. This leakeage should be checked occasionally to be certain of a system that is sufficiently leaktight for the required tests.

The altitude chamber, manometers, and Vol-O-Flo elements can be tested for leaks by evacuating the entire system and timing the rate of descent of the altimeter or altitude barometer indication when all valves are closed. In making this test the oxygen inlet should be capped as described above so that the oxygen pressure reducer does not become subjected to the vacuum. If the leakage rate is slow enough that the altitude indication does not decrease by more than 100 feet per minute, the system is adequately leaktight. Concurrent with the above altitude leakage test, the chamber should be evacuated to approximately 50,000 feet to remove dissolved air from the liquid in the manometers. After the completion of these tests, the rear cover can be replaced on the test stand.

STORAGE.—Before the test stand is placed in storage, the manometers should be drained. Consult the manufacturer's manual for information about this subject which also is related to shipment of the equipment.

Maintenance

INSPECTION.—The test stand should be inspected every 6 months as follows:

1. Inspect all rubber tubing connections. If they show signs of wear or cracking, replace them.
2. Check the rubber sealing gasket around the chamber, wash it with soap and water if necessary. Keep the chamber cover glass clean and free of chips.
3. The altimeter should be checked against a master altimeter or barometer to make certain it is within allowable tolerances.

LEAK CHECK.—Inspect the stand for leakage daily before running any tests. Evacuate to about 50,000 feet, hold for about 2 minutes, and drop the altitude to 40,000 feet. Close the valves fingertight. Time the rate of altitude loss for 5 minutes or more. The leak rate should be less than 100 feet per minute.

VALVE REPLACEMENT.—Remove the handle of the valve to be replaced. Remove the entire valve assembly by freeing its hose clamps and pipe clamps. Unscrew the valve from the piping, taking care not to bend or otherwise damage the assembly. Install a new valve using a suitable thread sealer such as glyptal, maintaining the original orientation of the piping assembly angles. Fit the assembly into the test stand. If the angles of the valve assembly have to be adjusted, again remove the assembly and adjust the angles to make a good fit. Replace all screws and clamps. Check all joints for leakage, tightening where necessary.

VOL-O-FLO ELEMENT CLEANING.—Disconnect the Vol-O-Flo element from the tubes which lead to the Vol-O-Flo manometers. Disconnect the flow element from the rest of the plumbing system by removing the hose clamps and rubber tubes at the ends of the element. Before the element is removed, put a directional mark on it so that on reassembly it will be connected the same way as initially. Using about a gallon of water with a teaspoon of detergent, flush the element in reverse from the direction in which air normally goes through it. For this operation, it is well to cap the two pressure taps on the side of the element to avoid spillage of the cleaning fluid.

After the element has been well flushed, the detergent should be rinsed out immediately with clean water. The element should than be placed in the test stand and air passed through it for about an hour to insure that it is completely dry. After drying the element, the test stand should be leak tested.

MANOMETER CLEANING.—Remove the glass manometer panel. Disconnect the rubber tubing attached to the pressure-suction manometer and remove the nuts and washers which secure the manometer to the test stand. Remove the manometer.

In order to remove the dual Vol-O-Flo manometer, it is necessary to first remove the manometer elements and piping.

Preparatory to cleaning, drain the manometer by opening the plug at the bottom of the case. Remove the drain plug and remove the overflow check valve at the top of the case. Pass a cylindrical tube cleaning brush soaked in alcohol completely through the tube several times. Rinse with clean alcohol and blow the tube dry using very dry air or gas. If dry gas is not available, permit the tube to air dry naturally. Do not wipe the inside of the tube, or blow it out with your breath. The overflow check valve should be soaked in alcohol until all dirt and particles are removed.

The well can be cleaned with a brush soaked in alcohol after removing the large cleanout plug on the back of the well. Rinse the well with fresh alcohol and dry as above. Reassemble the manometer and replace on the stand. Refill with King blue oil to the approximate zero level.

INTERCOMPARISON.—The inlet and outlet Vol-O-Flo manometer should be intercompared every 2 weeks, or before use of the stand if it has been idle for a period of more than 2 weeks. Cap the oxygen supply fitting in the chamber and evacuate the chamber to about 5,000 feet. With he bypass valve closed, adjust the flow to each, 5, 50, and 85 l.p.m., maintaining the simulated pressure altitude constant. Record the inlet and outlet indications simultaneously. Repeat his procedure at 15,000 and 30,000 feet. After applying the corrections in the existing calibraion charts, the flows should agree to within 2 percent or 1 l.p.m., whichever is greater. If hey differ by more than this for any test point, he manometers should be cleaned as previously described, and recompared. If the agreement s still unsatisfactory, the flow elements should be recalibrated at the factory. It is important hat these tests be conducted so that the chamber altitude is not changing when readings are taken. Also time should be permitted for the chamber emperature and room temperature to equalize o within approximately 33° F.

OTS-566 TEST STAND

The OTS-566 Test Stand is designed for esting diluter demand oxygen regulators under imulated altitude conditions. It was designed specially for use aboard ship, but can be used ashore as well. The OTS-566 incorporates Vol-O-Flo gages instead of manometers, otherwise it is practically identical to the OTS-565. These gages require no fluid, thus the roll of he ship has no effect on the readings.

Description of Components

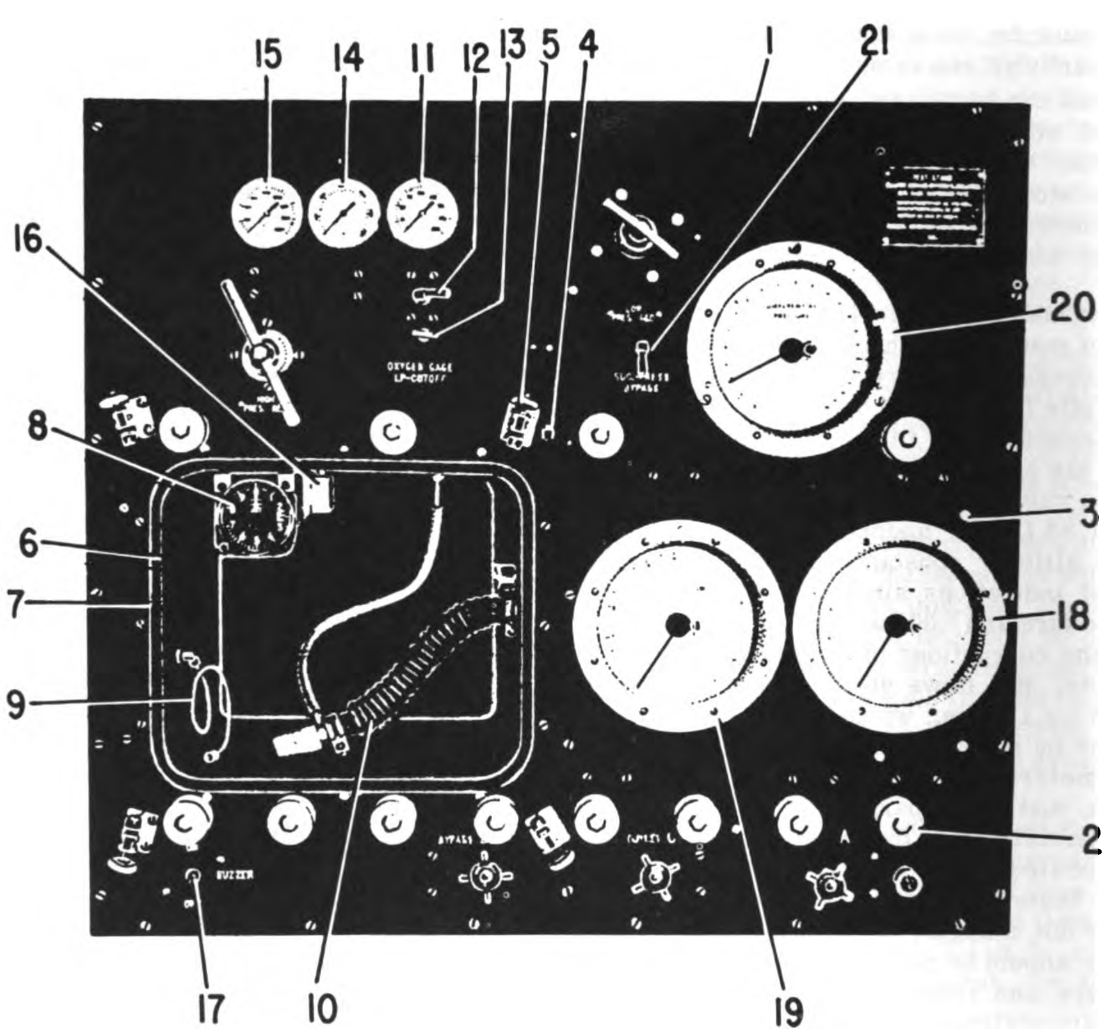
The test stand consists of an upper cabinet mounted on the lower pump stand. The upper abinet contains the altitude chamber, control valves, flow measuring gages, pressure-suction gage, altimeter, and piping. The lower pump stand contains a Gast vacuum pump identical to the pump used with the OTS-565. Front and rear views of the stand are shown in figures 11-5 and 11-6.

ALTITUDE CHAMBER.—An airtight chamber, mounted from the rear of the test stand panel, provides a space within which the various test altitudes may be simulated. The chamber is sealed by a cover plate, which rests on rollers, and can be clamped to the front of the chamber. The chamber has eight connections—a high-pressure oxygen inlet, an air inlet, two chamber pressure taps, a regulator outlet pressure tap, bypass outlet, and an electrical buzzer connection. One chamber pressure tap is connected to a barometer and is capped with a 1/8-inch pipe plug.

PIPING.—The piping consists of two major assemblies—an air inlet assembly and a regulator outlet-bypass assembly. The air inlet assembly is controlled by the air inlet valve and allows air to enter the altitude chamber. The outlet-bypass assembly permits either evacuation of the regulator outlet through an outlet valve, or evacuation of the altitude chamber through a bypass valve. The outlet-bypass piping assembly is connected to the pump in the lower cabinet by means of a rubber tube.

There is also an oxygen pressure reducer assembly installed in the test stand and connected to supply oxygen to the regulator under test. This assembly includes two regulators, a tank pressure gage, low and high range downstream pressure gages, an oxygen cutoff valve, a check valve, and a combination popoff and manual relief valve.

CONTROL VALVES.—Three needle valves are used. One, in the air inlet assembly, permits air to be bled into the altitude chamber, either to maintain a chamber altitude when the regulator is removing air from the chamber through its diluter air valve, or to permit bringing the chamber back to atmospheric pressure from a simulated altitude. The other two valves are in the outlet-bypass assembly. The outlet valve controls the flow of air-oxygen leaving the regulator. The bypass valve permits independent evacuation of the altitude chamber. It is used only to evacuate the chamber to change altitudes above 30,000 feet, or in an



1. Instrument panel.
2. Roller supports.
3. Glass end stops.
4. Glass midstop.
5. Toggle clamps and spacers.
6. Altitude chamber.
7. Chamber seal gasket.
8. Altimeter.
9. Regulator pigtail.
10. Corrugated rubber tube.
11. 200 p.s.i. gage.
12. Relief valve.
13. Oxygen cutoff valve.
14. 3,000 p.s.i. gage.
15. 4,000 p.s.i. gage.
16. Buzzer.
17. Buzzer switch.
18. Input gage.
19. Output gage.
20. Pressure suction gage.
21. Suction-pressure bypass.

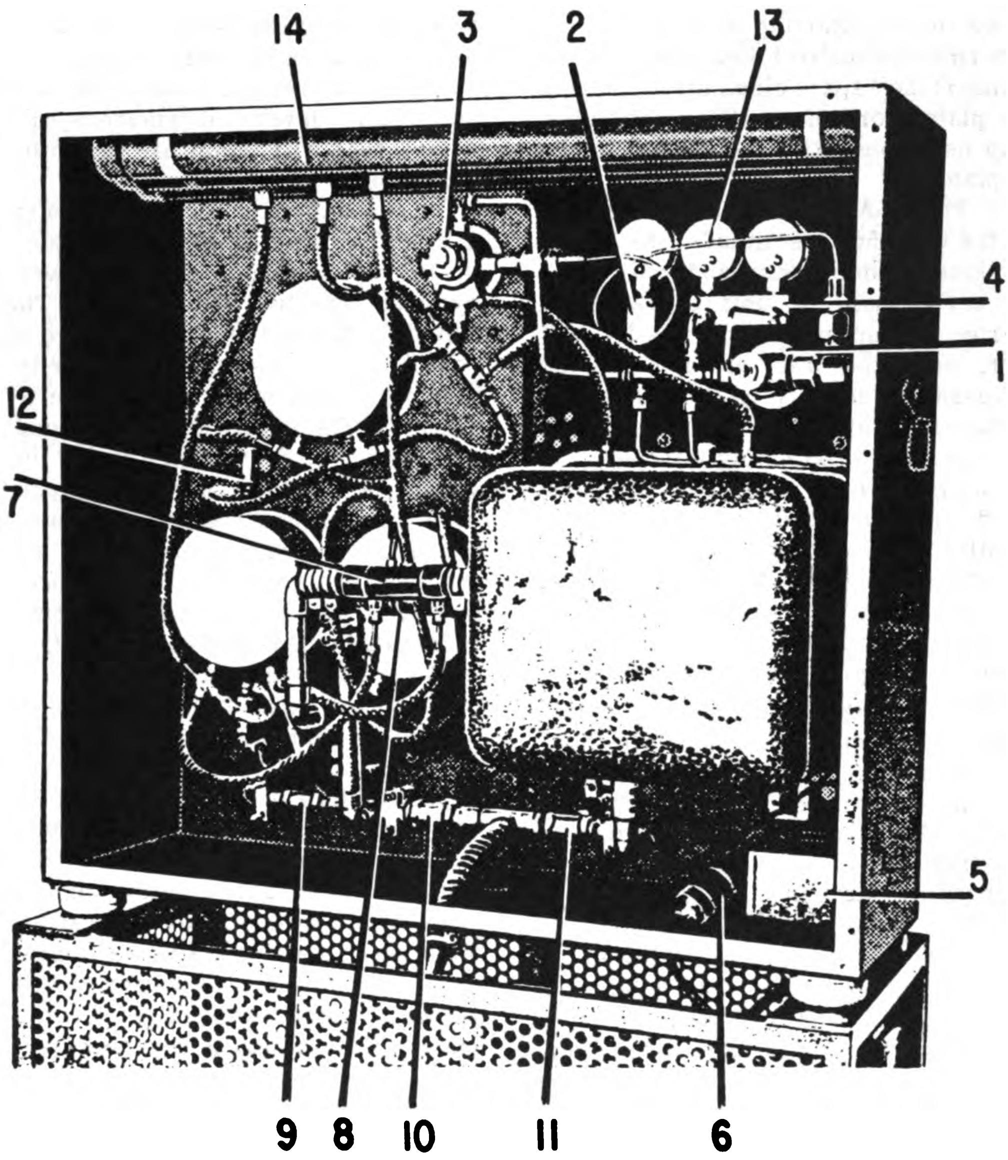
Figure 11-5.—Front view of the OTS-566 test stand panel.

emergency when the pressure-suction gage has been overloaded.

FLOWMETERS.—The two flowmeters (Vol-O-Flo elements) used in this test stand are the same as those described for the OTS-565 test stand.

Preparation for Use

ASSEMBLY.—The OTS-566 is shipped in crates. The test stand is assembled the sam as the OTS-565, assembling the pump stand first



1. Oxygen pressure reducer.
2. Gage mount block.
3. Oxygen pressure reducer.
4. Gage mount block.
5. Transformer, 220, 440 v.
6. Loctal plug.
7. Input Vol-O-Flo element.
8. Output Vol-O Flo element.
9. Inlet valve.
10. Outlet valve.
11. Bypass valve.
12. Check valve.
13. Pigtail reducer.
14. Ballast tank.

Figure 11-6.—Rear view of the OTS-566 test stand.

POWER REQUIREMENTS.—This test stand quires less than one KVA power. The OTS-6 test stand is wired for 440-volt operation. or operation on 440-volt, 3-phase power urces, bring a 3-wire line directly into the motor starting switchbox and connect the 3 phases. Be sure to check the direction of rotation of the pump as indicated by the arrow.

For operation on 220-volt, 3-phase a-c power sources, make up a 220-volt 3-wire line directly to the motor starting switchbox. Remove the 2 terminal overload elements from the switch and insert the 2 spare elements furnished. Remove the plate from the motor junction box and make up new connections as shown on the motor nameplate.

SETTING THE GAGES.—These new gages provided on the OTS-566 test stand have sensitive diaphragms inside them and may read slightly off zero when the unit is received. If this is true, clamp the glass to the front of the chamber, open the inlet valve, close the outlet and bypass valves, turn on the pump, then slowly open the outlet valve until the inlet and outlet flow gages read approximately 9 inches. The flow measuring gages have a range of 12 inches of water and are inscribed in linear inches. Close the outlet valve and again observe if the gages read other than zero. If so, unscrew the plug (on the dial glass) and use a screwdriver to turn the zero setting screw. After the gage is set to zero, the plug should be replaced.

ADJUSTMENTS.—Before using, the entire apparatus should be tested for leaks. The high-pressure oxygen system can be tested for leaks before the chamber is evacuated. This can be done by following the instructions for adjustments given for the OTS-565.

SPACE REQUIREMENTS.—Floor space (16 by 35 inches) is required for the test stand. An additional 15 to 20 inches should be allowed for the high-pressure oxygen cylinder to stand at the end of the test stand, and an additional 30 to 40 inches should be allowed in front of the stand for the operator to occupy. The total workspace allocated for the test stand should in no event be less than 50 by 50 inches.

Operation Instructions

The principles of operation for the OTS-566 test stand are the same as those outlined for the OTS-565. Keep in mind that the only major change or difference in these two test stands is that the OTS-566 test stand utilizes gages instead of manometers.

VACUUM PUMPS

Up to this time, vacuum has been mentioned many times and nothing about the vacuum pump. The vacuum pump is the device that is used to draw air out of the chamber of oxygen regulator test stands. Fifty years ago vacuum pumps were used almost exclusively in physics laboratories, but today industry and many other fields of enterprise have developed hundreds of uses for the device that will pump air and other gases out of a vessel.

A basic form of mechanical pump consists of a cylinder fitted with a piston (such as is found in liferaft pumps). At the lower end of the cylinder are two short tubes. The fittings to which the tubes are connected are equipped with conical type valves (very similar to the type and body arrangement of the oxygen system check valves). These valves are arranged so that when the piston is drawn up, the air in the vessel, which is to be exhausted, expands into the cylinder through the inlet valve. Pushing the piston down compresses the air; and as a result, the inlet valve closes while the outlet valve opens. With each cycle (double stroke) a fraction of the air in the vessel is removed. This fraction is the ratio of the volume of the cylinder to the combined volumes of the cylinder and the vessel.

As an example, consider that the vessel has a capacity of 9 liters and the pump cylinder a capacity of 1 liter. This is a combined capacity of 10 liters. A mechanically perfect pump could remove one-tenth of the air after the first stroke, while the fraction of air remaining (nine-tenths) would expand to fill the 10 liters. With the second stroke, one-tenth more of the remaining air would be removed, leaving nine-tenths of nine-tenths of the original air in the pump. This action is repeated on each successive stroke.

Even after the application of a mechanically perfect pump, a chamber cannot be completely evacuated; since with each stroke, only a fraction of the air is removed while the remainder expands to fill the chamber. Actually, no pump is perfect, they all leak. However, with some types it is possible to obtain a very high degree o vacuum. When only about one-millionth of th air normally present in a chamber is left, is almost perfect.

With a regulator test stand, such a high degre of vacuum is not necessary. To simulate 20,00 feet, at which altitude the atmospheric pressu is 6.7 p.s.i., the vacuum pump must reduce th chamber pressure 8.0 p.s.i., the difference be tween the sea level atmospheric pressure 14.7 p.s.i. and 6.7 p.s.i. When we consider th the pressure must be reduced and held for eac ucceeding rise in altitude up to 28,000 to 32,000 vhen the air valve of the regulator closes), must also be realized that under these con- itions, air is being admitted into the chamber.

After the air valve has closed and the input f air is no longer necessary, it is an easier sk for the vacuum pump. This is true up to a oint, but if the pump does not have the capacity r reducing the pressure in the chamber low nough to simulate 50,000 feet (altitude neces- ary for the pressure breathing back tests), a rger capacity pump will be needed. The test tand manuals recommend a vacuum pump with capacity of approximately 6 standard cubic eet per minute at 35,000 feet.

Gast Vacuum Pump

CONSTRUCTION.—The rotary Gast pump is precision product, there being only 0.0015 to 0065 inch total clearance at the ends and top the rotor. The vanes take up their own wear d should last from 5,000 to 25,000 hours oper- ion, depending upon the application. Remem- r that it is designed for pumping dry air. rotect it against the entrance of dirt and ex- ssive moisture. Lubricate it regularly and operly, and you will receive years of trouble- ee service.

INSTALLATION.—The location of the Gast mp should be on a solid base plate, preferably metal, which in turn should be anchored to shelf, the floor, a foundation, or to other achinery. To save time and inconvenience, ace the pump so as to provide access to the l reservoir and large glass oil trap.

Notice that standard rotation is counterclock- se, with the pump shaft extending toward the wer. (See fig. 11-7.) Use sufficient horse- wer. Figures in the manufacturer's tables ll for pump speed of 1,750 r.p.m. unless erwise specified. For direct drive, study drawing and align the pump and motor afts. For V-belt drive, remove the fan and ard from the drive end so that the sheave y be installed nearer the bearing. Speed may nge from 1,000 to 1,800 r.p.m., but choose a mp sheave of good diameter, such as 4 to 5 hes.

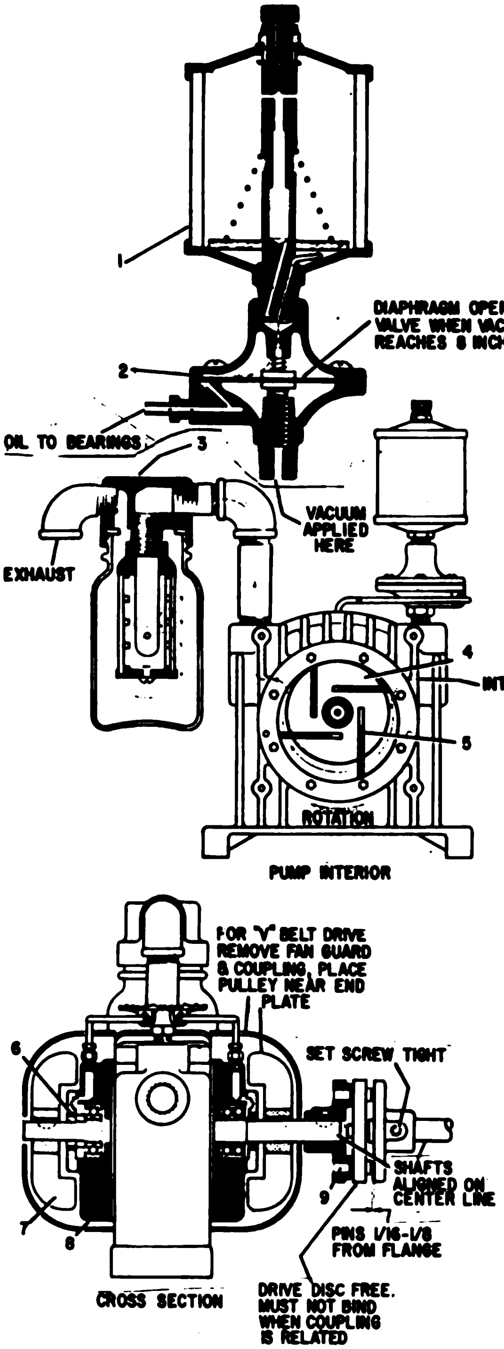
Connections are standard pipe thread. Avoid use of extra elbows in the line, and give the e a uniform slope. Place a drain cock at the low point. For ease of servicing, use a union or hose with clamps near the pump. A hose helps eliminate noise and vibration. The muffler may be removed and the exhaust piped directly out of the building.

LUBRICATION.—The instructions are affixed in the oiler glass. Use a light oil or pure mineral oil without additives, having a viscosity equivalent to SAE 10. For installations in warm climates or where room temperature is high, use heavy medium oil having a viscosity equivalent to SAE 20 or 30. For installations below freezing, change to arctic or dilute a slightly heavier oil with 1/4 or less kerosene. Additives in some oils (especially SAE automative types) may cause corrosion on any metal parts contacted or leave a jelly-like deposit in oiler and pump chamber. On vacuum operation below 10 inches, a different type of lubricator is required. One filling of the oil reservoir should last 50 to 200 hours operating time, depending upon the application.

SERVICING.—If vacuum builds up slowly, examine the connecting lines for leaks. Vanes may be sticking in slots due to lack of oil, too much oil, or the oil may be too heavy. Flush by permitting several teaspoonfuls of kerosene to be drawn into the intake while the pump is running. Lubricate as previously described. Removing the end plate, preferably opposite the drive shaft end, will permit the removal of the 4 sliding vanes for a thorough cleaning in a solvent and also provide accessibility to any particles which must be removed. The original gaskets are onionskin. Only a few thousandths clearance is required, and any thicker gaskets will greatly reduce the pump efficiency.

CLEANING.—Exhaust and intake filter felts may be removed and washed in solvent. Stop the pump first, otherwise dirt may be sucked into the pump.

INSPECTION.—Periodic inspection will prevent expensive repairs. Do not be alarmed if the pump temperature reaches 150° to 250° F. when running continuously. If exhaust fog is objectionable, remove the muffler and pipe exhaust out of building. Occasionally, examine the shaft for side or end play by moving it manually while the pump is idle. If the pump or motor shows evidence of overheating or excessive noise, stop immediately until the pump is repaired. In remote locations, it is a good practice to have a spare pump on hand.


1
2
DIAPHRAGM OPENS VALVE WHEN VACUUM REACHES 8 INCHES
OIL TO BEARINGS
3
EXHAUST
VACUUM APPLIED HERE
4
INTAKE
5
ROTATION
PUMP INTERIOR
FOR "V" BELT DRIVE REMOVE FAN GUARD & COUPLING, PLACE PULLEY NEAR END PLATE
SET SCREW TIGHT
6
SHAFTS ALIGNED ON CENTER LINE
9
PINS 1/16-1/8 FROM FLANGE
7
8
CROSS SECTION
DRIVE DISC FREE. MUST NOT BIND WHEN COUPLING IS RELATED

1. Oil reservoir assembly.
2. Vacuum lubricator assembly.
3. Exhaust muffler and oil trap. (Standard equipment on all pumps.)
4. Rotor and shaft.
5. Vanes (4 required).
6. Shaft seal, drive end.
7. Cooling fan, dead end.
8. Rotor and shaft.

Nomenclature for figure 11-7—Continued

9. Flexible drive coupling assembly.

Figure 11-7.—Interior and cross section view of vacuum pump (Gast).

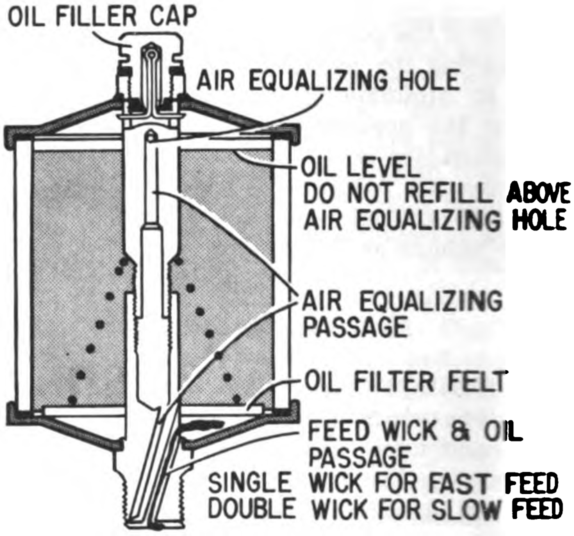

OIL FILLER CAP
AIR EQUALIZING HOLE
OIL LEVEL DO NOT REFILL ABOVE AIR EQUALIZING HOLE
AIR EQUALIZING PASSAGE
OIL FILTER FELT
FEED WICK & OIL PASSAGE
SINGLE WICK FOR FAST FEED
DOUBLE WICK FOR SLOW FEED

Figure 11-8.—Oil reservoir, Gast vacuum pump.

Oil Reservoir

FILLING AND OPERATING.—It is easier t
fill the oil reservoir while the pump is runnin
Use an oil can with a slender spout and push
through the side hole inside the filler opening
a 45-degree angle. (See fig. 11-8.) If possibl
extend the spout clear of the center post so t
oil will not run into the air equalizer passage
the post. To avoid the oil reaching the ai
equalizer hole, do not fill above the bottom o
the top flange. Do not replace the oil fille
cap immediately after refilling. Let the pu
run a few minutes so any excess oil will
sucked out of the equalizer passage. When th
has been done, replace and tighten the filler ca
Each time the pump is oiled, empty the exha
trap. Do not use this oil again as it usually co
tains condensed moisture.

OIL FEED CONTROL.—A simple gravity o
ing system depends upon keeping the air equ
izer passage open and on the choice of wic
(smokers' pipe cleaners). The standard fe
uses a double wick on small 4-ounce capac
cups, and a single wick on large 8-ounce cu

this way, one filling lasts equally as long r both cups. The above wick selection can be ıanged on special applications.

IMPROPER FEED.—Improper feed might be ıused by an oil filled equalizer passage, loose lercap, or a defective wick. Change wicks if ey appear defective. To change the wick, un- rew the oil reservoir from the lubricator sting and pull the oil wick out of the bottom, ing pliers. Insert a new wick (if double, insert ubled end first) from the bottom until it touches e filter felt. Cut off the end so it extends for out 1/8 inch beyond the hold. Be certain that e wick is placed in the center hole and not in e side hole. (See fig. 11-8.)

Models R-15 and R-17

These vacuum pumps are manufactured by ıe Quincy Compressor Company of Quincy, linois, and are practically identical in con- ruction. The R-15 is illustrated in figure -9.

INSTALLATION.—The pump should be in- alled in a lighted area free from excessive ıst, and where there is enough room for spection of the unit. The pump should be bolted a substantial level foundation, where it will ıt break away from the power unit. The piping tween the vacuum pump and the test stand, ıd from the discharge opening in the pump to e atmosphere, should be equal to the full ameter of the openings in the pump. In ad- tion, the piping should be as free from bends possible and care should be taken to insure at the entire line is free from scale and reign matter which might be drawn into the ımp and lodge under the valves.

LUBRICATION.—Before starting the vacuum mp, fill the crankcase to the full level mark on the bayonet oil level gage. Oil should be added when the level falls to the low mark. Use a good grade of automobile engine oil. If the temperature (where the pump is located) is 32° or above, use SAE 20; below 32°, use SAE 10. Change the oil when it becomes dirty, cleaning the crankcase before refilling. The time between changes is purely problematical.

PUMP SPEED.—The minimum speed of the pump is 400 r.p.m. and the maximum speed is 940 r.p.m. The speeds at which it can be run with various size electric motors follow:

Model No. R-15 1/3 hp. 400 r.p.m. (piston displacement, 7.2 cubic feet).

Model No. R-15 1/2 hp. 525 r.p.m. (piston displacement, 9.5 cubic feet).

Model No. R-17 3/4 hp. 800 r.p.m. (piston displacement, 14.5 cubic feet).

Model No. R-17 1 hp. 940 r.p.m. (piston displacement, 17.0 cubic feet).

ELECTRIC MOTORS.—Avoid low voltage conditions. Make certain that the motor is the correct type for the available current. In most cases, an electrician will be responsible for the installation; however, there are a few single tasks that can be performed by the Parachute Rigger. These would involve little more than keeping the motor clean and lubricated.

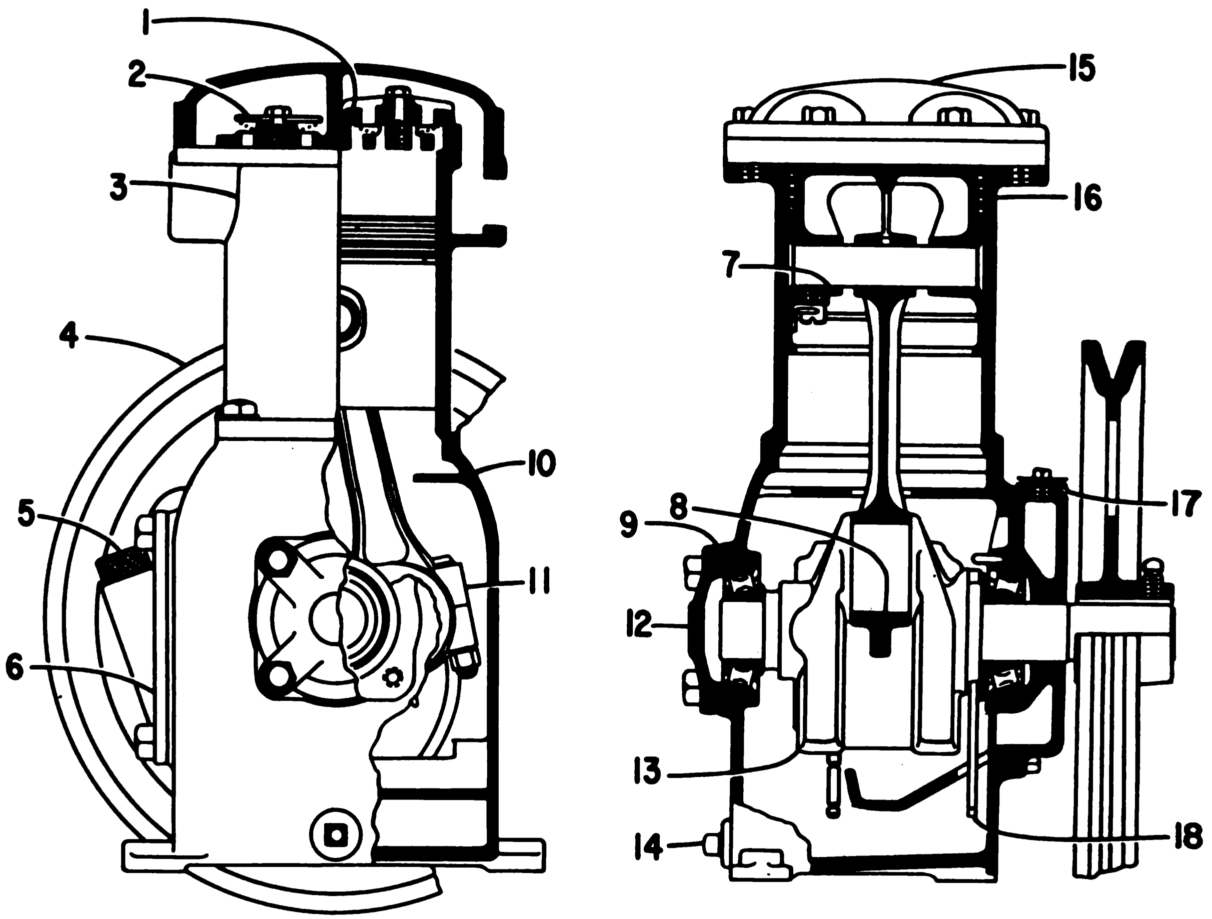
ENGINE DRIVEN PUMPS.—Instructions for the care of gasoline power units are shipped with the equipment. Read them carefully before attempting to set up or operate the assembly.

V-BELT.—When the drive is by V-belt, excessive tension is not necessary but slippage is NOT permitted. The driving pulleys of the motor and pump must be aligned perfectly to avoid unnecessary wear of the belt and machine bearings.

Liquid Oxygen Converter Buildup, Flow, and Heat Loss Test Stand

Aircraft liquid oxygen converters must be le to store liquid oxygen and deliver gaseous ygen of the correct breathing temperature to users as required. These factors are de- ndent on each converter being in reliable rking condition.

The liquid oxygen converter buildup, flow, and heat loss test stand was specifically designed to insure a high degree of reliability for the liquid oxygen converter by providing the means for periodic preventive maintenance tests and adjustments.



1. Suction valve seat.
2. Discharge valve bumper.
3. Cylinder.
4. Pulley, 11 5/8-inch diameter.
5. Bayonet oil level gage.
6. Inspection plate.
7. Piston (standard).
8. Connection rod bearing.
9. Shim for bearing adjustment (0.005 inch thick).
10. Crankcase.
11. Connecting rod assembly.
12. Bearing adjustment plate.
13. Crankshaft.
14. Oil drain plug.
15. Head.
16. Piston rings (standard vacuum).
17. Breather valve.
18. Oil circulating ring.

Figure 11-9.—Vacuum pump, R-15, manufactured by the Quincy Compressor Company (size 4 by 2 1/2).

DESCRIPTION OF COMPONENTS

The test stand, shown in figure 11-10, consists of the test stand proper, a scale, and a pressurized heat loss kit. This test stand was designed to test all known low-pressure liquid oxygen converters currently in use by the Navy.

Flowmeter

The test stand has a variable area gl tube type flowmeter (3). It is graduated fr 20 to 210 l.p.m. There are additional graduati above and below these figures to read as as 10 l.p.m., and as high as 216 l.p.m. flowmeter records the rate of flow of gase oxygen from the converter.

Pressure Gage

The pressure gage (2) records the internal pressure of the converter under test. The pressure gage is calibrated from 0 to 160 p.s.i.

Evaporator Coil

There is an evaporator coil built into the bottom of the test stand for converters that do not have a coil as an integral unit.

Supply Valves

There are two supply valves (4 and 5) located on the bed of the test stand. These valves control the flow of gaseous oxygen. One valve is to be used with converters without a coil and the other is for use on converters with a coil.

Connections

The connections between the test stand and the converter being tested are located on the right side when facing the stand.

Following is a list of the connections:

Vent to converter (7).
Buildup to converter (8).
Fill to converter (9).
Supply valve with coil to converter (10).
Supply valve without coil to converter (11).
Test stand vent (12).

Scales

The scales are provided for conducting the vaporation heat loss tests by the weight method. he scales are an integral part of the test stand r determining evaporation heat loss under both ented and pressurized conditions. The dial face graduated in one-ounce increments from 0 to 5 pounds. With a tare poise and a capacity oise on the scale it can show weights up to 150 ounds.

The scale is an extremely sensitive, non-pring, weight-indicating device. There is a cking handle located in rear of the scale. The ndle should be kept in the locked position hen the scale is not in use to prevent damage the scales.

Pressurized Heat Loss Kit

The pressurized heat loss kit is used for rforming the heat loss test on converters der pressurized conditions. The components of the kit include a pressure gage calibrated from 0 to 200 p.s.i., flexible metal hose, plugs, and connectors.

TYPES OF TESTS

All tests performed on converters must be performed in reference to the operating manuals for whatever particular converter being tested. All converters do not fall within the same limits as to pressure, flow, heat loss, and filling time.

Connection Procedure

The proper steps for connecting the converter to be tested follow:

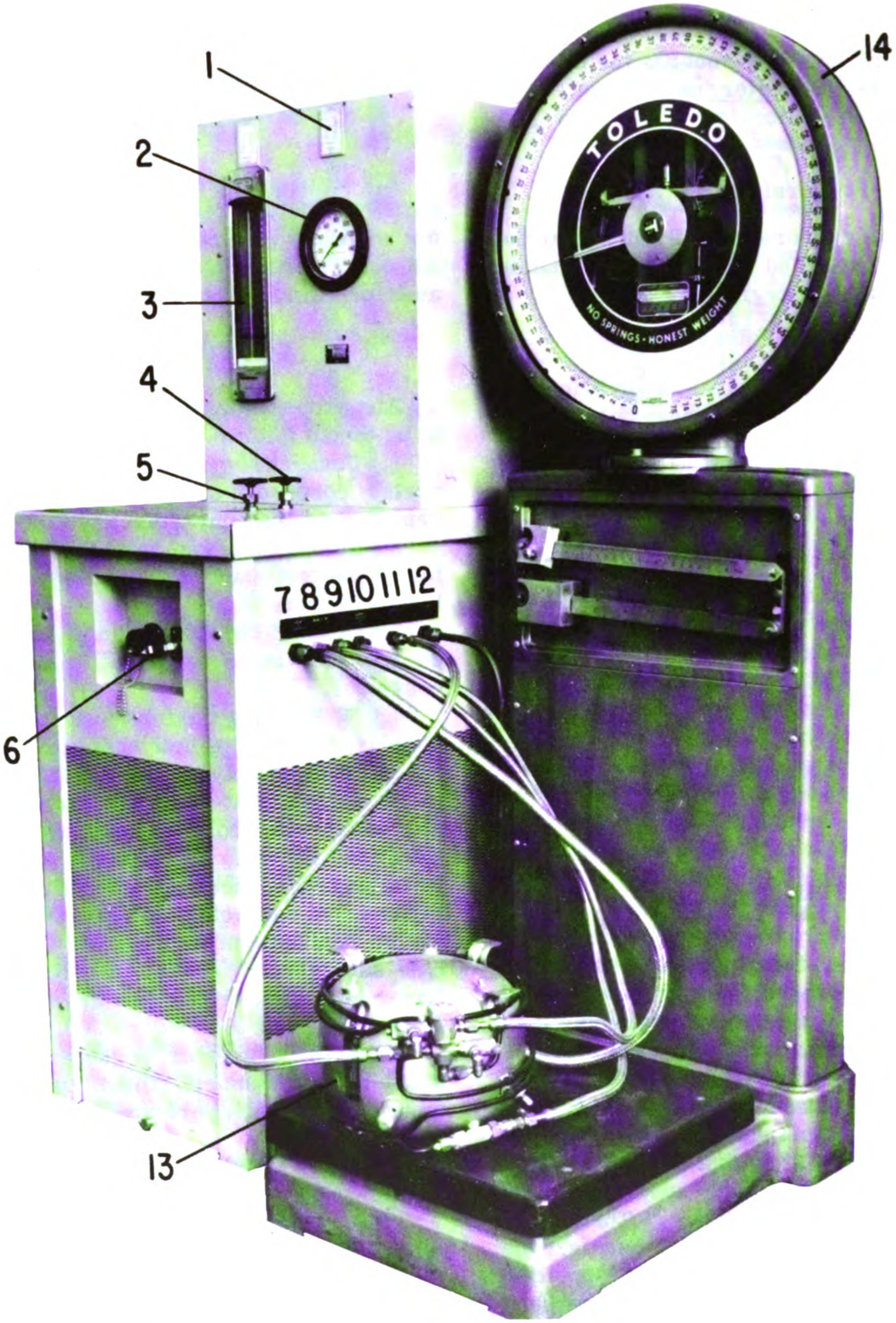
1. Connect the flexible hose from the converter connector on the test stand to the gas vent port on the converter.
2. Connect the hose from the buildup connector on the test stand to the buildup connector on the converter.
3. Connect the hose from the fill connector on the test stand to the fill connector on the converter.
4. Connect the flexible hose from the supply converter with the coil connector on the test stand to the supply connector on the converter to be tested; that is, if the converter has its own evaporating coil. If the converter does not have its own coil, make use of the coil on the test stand by connecting to the supply converter without coil connector. When using supply converter connections, make sure that the alternate supply valve on the test stand is closed. Never plug, cap, or obstruct the converter pressure relief vent.

When the converter is connected to the test stand in this manner, filling, buildup, and flow tests can easily be performed.

Filling Converter

Prior to beginning the tests on the converter, it should be filled in the following manner:

1. Place the converter on the scales and have it connected as listed in the connection procedure.
2. Place the test stand buildup and vent valve in the vent position. If the converter has a buildup and vent valve, it is also to be placed in the vent position.
3. Make certain that both test stand supply converter valves are closed.



1. Correction cards.
2. Pressure gage.
3. Flowmeter.
4. Supply valve for converter without coil.
5. Supply valve for converter with coil.
6. Buildup and vent valve.
7. Connection, vent to converter.
8. Connection, buildup to converter.
9. Connection, fill to converter.

Nomenclature for figure 11-10—Continued.

10. Connection, supply valve with coil to converter.
11. Connection, supply valve without coil to converter.
12. Test stand vent.
13. Converter being tested.
14. Scales.

Figure 11-10.—Liquid oxygen converter buildup, flow, and heat loss test stand.

4. Connect the transfer hose to the test stand filler valve.

5. Regulate the transfer pressure between 25 and 35 p.s.i. and admit liquid oxygen until a steady stream flows from the test stand vent connection.

6. Disconnect the transfer hose.

Pressure Buildup Test

The buildup test is to determine if the converter reaches the operating pressure in the required length of time specified for the particular converter being tested. The procedure for performing this test follows:

1. Place the test stand buildup and vent valve in the buildup position and record the time started. If the converter being tested has a buildup and vent valve incorporated, it is to remain in the vent position.

2. Record the time that the pressure gage reaches the specified operating pressure. Compare the time interval with the performance specifications for the applicable converter to determine pass or fail condition.

Flow Test

The flow test is to determine if the converter elivers the required amount of flow of gaseous xygen to the user, as specified by the manual or the particular converter being tested. The rocedure for performing the flow test follows:

1. With the converter connected in the proper manner, slowly open whichever supply valve on he test stand is associated with the type of conerter (with or without coil).

2. Set the flowmeter at specified rate of flow rom the manual for the type of converter being ested).

3. Maintain this flow for the specified time nd check the test stand pressure gage for the pecified tolerance.

4. Slowly close the supply valve being used, and place the buildup and vent valve in the vent position.

Vented Evaporation Heat Loss Test

The heat loss test, either vented or pressurized, is to determine if the converter under test falls within the specified limits as to the allowable evaporation.

Make certain of the following connections:

1. Connect the flexible hose from the filler connection on the test stand to the filler port on the converter.

2. Connect the flexible hose from the vent to converter on the test stand to the gas port on the converter.

All other converter ports except the pressure relief vent will be capped or plugged.

3. Fill the converter through the test stand as previously given.

4. Unlock the scale locking handle by turning 1/4 turn clockwise, and record the weight of the filled converter. If the specification for the converter being tested calls for a stabilization period, wait for exactly this time and then record the weight of the converter. This period will usually be 1 or 2 hours.

5. Allow the converter to remain at rest for the specified time interval, which is usually 24 hours, then record the weight again.

6. Check the weight loss with the specifications for the converter.

If the specifications give the loss in liters, divide the weight loss by 2.48 pounds to convert weight to liters.

Pressurized Evaporation Heat Loss Test

The procedure for testing a converter under pressure follows:

1. If the converter is still 75 percent full from the previous test, proceed to this test; if not, refill the converter.

2. Remove the plug from the converter supply port and attach the 0 to 200 p.s.i. pressure gage to this port.

3. Connect the flexible hose between the vent gas port on the converter and the buildup port on the converter. Check that all other ports except the pressure relief vent are either plugged or capped.

4. Record the weight of the converter and allow it to remain at rest for the specified time. Record the weight again after duration of the test period called for in the specifications.

5. Loosen the flexible hose from the fitting on the converter vent port, releasing all the pressure, then disconnect the opposite end. Remove the pressure gage and all the remaining plugs or caps.

Leak Test on the Test Stand

In order to insure that the test stand is always in maximum working condition, a leak test is to be performed weekly in the following manner:

1. Plug the outlet port of the flowmeter.
2. Plug the open end of the flexible hose connected to the supply converter without the coil connection.
3. Interconnect the hose between the supply converter with the coil connector and the buildup connector.
4. Place the buildup and vent valve in the buildup position.
5. Open both supply converter valves.
6. Connect gaseous oxygen supply with an adjustable regulator to the vent to converter connection on the test stand.
7. Apply 150 p.s.i., which is read on the test stand pressure gage.
8. Allow the pressure to remain for 10 minutes. The allowable loss in pressure is 5 p.s.i. If there is excessive loss, soap all the fittings to find the leak.

MAINTENANCE

Very little maintenance is necessary on this test stand. One of the most important preventive maintenance items is to keep the equipment clean and free from oil and dust.

Scale

The scale should be lubricated occasionally at the dashpot and the lower oil seal. The zero adjustment is through the hole on the left side of the scale. No further adjustment should be attempted on the scale.

Pressure Gage Adjustment

The pressure gage should be checked daily to determine if it reads zero with no pressure applied. To adjust the gage, remove the back cover of the test stand and turn the adjusting screw through the hole in back of the gage until the pointer indicates zero.

Calibration of the Flowmeter and Pressure Gage

The calibration of the flowmeter and pressure gage is to be conducted monthly, in the following manner:

1. Connect the master flowmeter to the supply converter with the coil connection and pass the specified flows through flowmeter. Make out correction cards if necessary.
2. Connect the master pressure gage to the buildup connection on the test stand and set the specified pressure on the master gage. Make out correction cards if necessary.

Liquid Oxygen Accessories Test Stand

The lives of the pilot and crew and the success of a mission are dependent on the continuous supply of oxygen. These factors, in turn, are dependent upon the reliability of the liquid oxygen system. The liquid oxygen accessories test stand was designed to insure a high degree of reliability for the converter components and accessories by accurately testing them for proper performance. The test stand is shown in figure 11-11.

DESCRIPTION OF COMPONENTS

Supply Pressure Gage

The supply pressure gage (9) is calibrated from 0 to 2,000 p.s.i. This gage indicates the remaining pressure in the supply cylinder.

Test Pressure Gage

The test pressure gage (3) is bourdon-tube-operated and calibrated from 0 to 400 inches of water. The test gage indicates the pressure being applied to the item under test.

Differential Pressure Gage

The differential pressure gage (4) is a bellows-operated gage and is calibrated from 0 to 100 inches of water. The differential pressure gage indicates the changes in pressure. One side of the bellows is connected to the male quick disconnect protruding on the face of the stand. The other side of the bellows connects into the system pressure.

Differential Pressure Gage Shutoff Valve

The differential pressure gage shutoff valve (6) controls the flow of pressure to one side of the gage. This valve must be on when using the differential pressure gage. The purpose of the valve is to protect the differential gage from damage when not in use.

Flowmeters

The flowmeters are of the variable area glass tube type. Each flowmeter is individually mounted with a male quick disconnect fitting beneath each flow rater. There are two rate flowmeters (1) (high range) on the right side of the test stand. From left to right they are graduated to measure from 3 to 35 l.p.m. and 28 to 295 l.p.m. There are two leakage flowmeters (2) (low range) on the left side. They are graduated to measure from 0.003 to 0.05 l.p.m. and 0.04 to 0.46 l.p.m. The purpose of the flowmeters is to measure the amount of flow from the items under test.

Bell Jar Assembly

The bell jar (11) is located on the counter of the stand. There is an internal connector located in the base of the jar. It is the female portion of the quick disconnect. The bell jar is used when testing components made of several joined pieces or fittings, where the possibility of several leaks exists. To prevent excessive pressure in the bell jar, a spring-loaded relief valve is incorporated in the hose. The relief valve is set to relieve the pressure at 6 p.s.i.

Adapter Fixture

The adapter fixture is located inside the cabinet below the bell jar. There is a relief valve set at 410 to 470 p.s.i. to relieve excessive pressure in the test stand system. The adapter fixture routes oxygen to the following components:

1. Female quick disconnect inside the bell jar or to the item under test.
2. Test pressure gage.
3. Differential pressure shutoff valve.
4. System bleed valve.

Metallic Flex Hose

There is a 24-inch metallic flex hose furnished with the test stand. The hose has female quick disconnects on both ends. It connects items under test or the bell jar directly to any flowmeter or to one side of the differential pressure gage.

Pressure Regulator

The pressure regulator (10) is factory preset at 400 p.s.i. to protect the test gage. The regulator can be used if desired to regulate the pressure to the item under test. The pressure regulator regulates and routes oxygen to the supply oxygen valve.

Supply Oxygen Valve

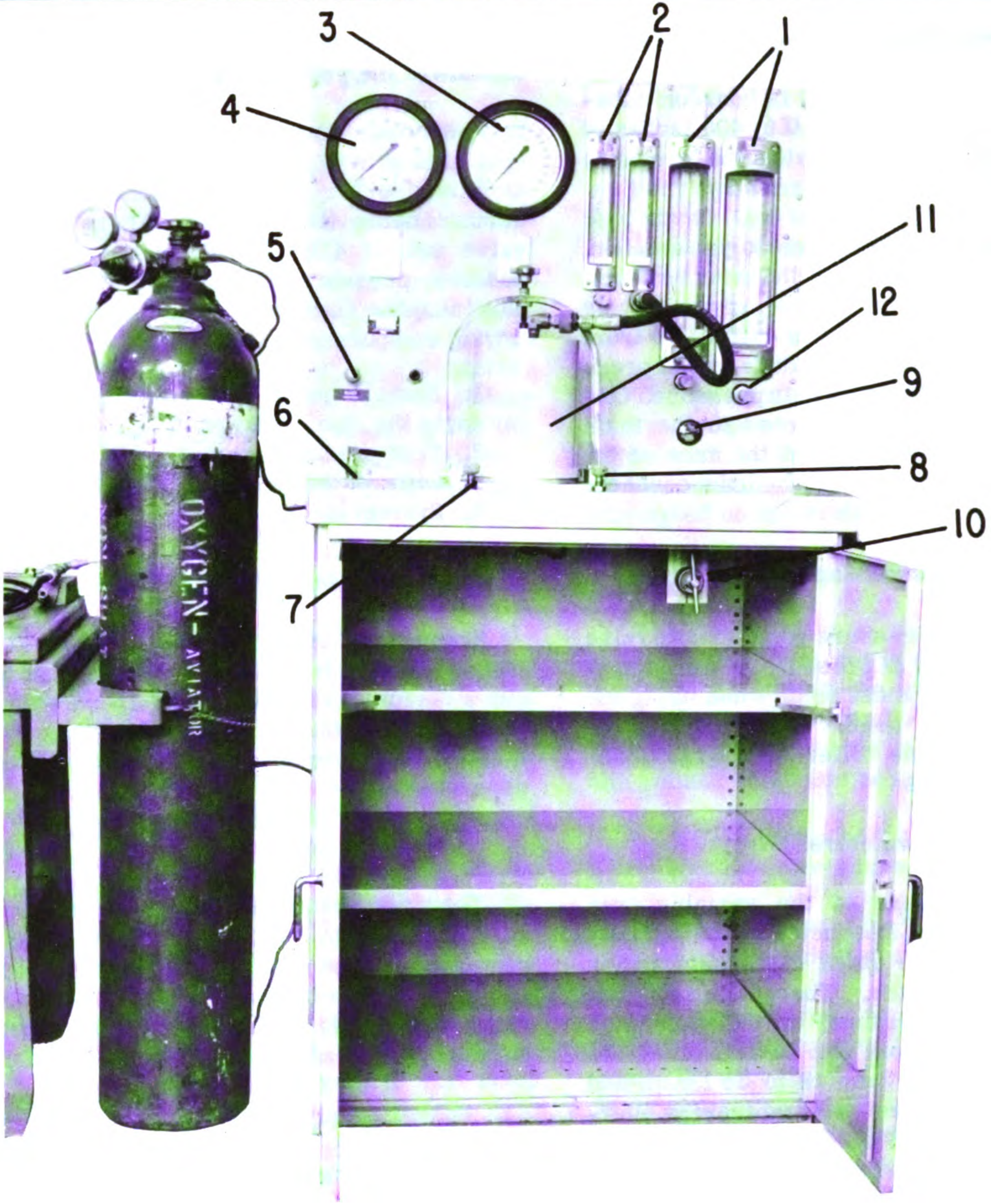
The supply oxygen valve (8) is a needle type valve and admits pressure to the adapter fixture.

System Bleed Valve

The system bleed valve (7) is also a needle type valve and is used to bleed pressure from the adapter fixture.

Adapter Set

An adapter set is furnished with the test stand which contains all the necessary adapters and plugs for connecting components that are to be tested.



1. High-range flowmeters.	7. System bleed valve.
2. Low-range flowmeters.	8. Oxygen supply valve.
3. Pressure gage.	9. Oxygen supply gage.
4. Differential pressure gage.	10. Pressure reducer.
5. Bleed valves for differential pressure gage.	11. Bell jar.
6. Shutoff valve for differential pressure gage.	12. Male portion of disconnect.

Figure 11-11.—Liquid oxygen accessories test stand.

TYPES OF TESTS

Before commencing any test, check to see that the test pressure gage and the differential pressure gage are indicating zero. Keep in mind that specific operating pressures and flows must be taken from the overhaul manual for the particular item being tested.

Flow Test

The flow test is checking an item that is required to pass a specified amount of flow. The procedure for flow testing a relief valve is as follows:

1. Connect the valve to the proper adapter, and connect the valve adapter to the quick disconnect fitting in the bell jar base.
2. Connect the valve directly to the appropriate rate flowmeter with the flex hose.
3. Slowly open the supply oxygen valve to the specified pressure as indicated on the test gage pressure.
4. Read the amount of flow on the flowmeter and compare with the specified amount of flow given for the valve.
5. Close the oxygen supply valve, open the system bleed valve, and remove the item from the test stand.

Leak Test

The leak test is performed on items to check for leakage and to measure any slight amount of allowable leakage. Following is the procedure for checking the leakage on a filler valve:

1. Connect the valve to the proper adapter, and connect the valve adapter to the quick-disconnect fitting in the bell jar base.
2. Install the bell jar cover and connect the bell jar to the appropriate leakage flowmeter with the flex hose.
3. Slowly open the supply oxygen valve to the specified test pressure as indicated on the test pressure gage.
4. Read the amount of leakage, if any, on the leakage flowmeter.
5. Turn the oxygen off, bleed the system, and remove the valve.

Pressure Test

The pressure test is to check an item for pressure holding, or releasing characteristics. The procedure follows:

1. Connect the accessory to be tested to the proper adapter and connect the adapter to the quick disconnect in the bell jar base.
2. Open the supply oxygen valve to the specified test pressure and then close. Observe the test pressure gage for the required time and check for pressure drop.
3. Bleed the system and remove the item from the test stand.

Differential Pressure Test

The differential pressure test is to determine the opening or closing pressures on the item to be checked. The procedure for checking a pressure control valve follows:

1. Connect the valve to the proper adapter and connect the adapter to the quick disconnect in the bell jar base.
2. Connect the flex hose from the valve to the male portion of the disconnect on the differential pressure gage.
3. Open the differential pressure gage shutoff valve by raising it to the vertical position.
4. Slowly open the supply oxygen valve to the specified closing pressure of the pressure closing valve.
5. Increase the pressure slowly and observe both the test pressure gage and the differential pressure gage.
6. Record the reading on the test pressure gage at the exact moment the differential pressure gage pointer jumps away from zero. This is the closing pressure of the valve.
7. Increase the oxygen pressure further and record the reading on the test pressure gage at the exact moment the differential pressure gage pointer moves back to zero. This is the opening pressure of the valve.
8. Close the supply oxygen valve, bleed the system, and remove the valve from the test stand.

MAINTENANCE

Leak Test On the Test Stand

A leak test on the test stand is to be performed weekly in the following manner:

1. Cap the outlet ports on both leakage flowmeters.
2. Install the bell jar and connect it to one of the flowmeters, using the flex hose.
3. Open the differential pressure gage shutoff valve.
4. Slowly open the supply oxygen valve until the differential pressure gage indicates 100 inches of water pressure. Close the supply oxygen valve.
5. Wait 10 minutes and read the differential pressure gage. Maximum allowable drop is 2 inches of water pressure. If there is excessive leakage indicated, soap the bell jar base, flex hose connections, and flowmeters to determine the leak.
6. Connect the flex hose to the other flowmeter and repeat the test.
7. Open system bleed valve, close the differential pressure gage shutoff valve and remove the bell jar.
8. Plug the flex hose to the quick disconnect in the bell jar base and apply 400 p.s.i. oxygen pressure as indicated on the pressure gage. Wait 10 minutes and read the pressure gage. Maximum allowable drop is 5 p.s.i.
9. Open the system bleed valve. Close differential pressure gage shutoff valve.

Adjusting Test Pressure Gage

The test pressure gage is checked daily to determine if the pointer is indicating zero. If the gage is not indicating zero, remove the cover from the back of the stand and turn the adjusting screw back of the gage until the gage is indicating zero.

Adjusting Differential Pressure Gage

If the differential pressure is not indicating zero, loosen the screw in the base of the gage bezel, pull the bezel out slightly, and lift the assembly forward and away from the dial. Insert a screwdriver into the small access hole on the dial face and turn adjustment screw until the gage indicates zero.

Adjusting the Pressure Regulator

The pressure regulator is checked once a month. Loosen the hex nut on the pressure reducer and back the handle out. Plug the quick disconnect in the bell jar base. Open the oxygen supply fully and turn the pressure reducer until the pressure gage indicates 400 p.s.i. Tighten the hex nut which locks the handle.

Checking the Bell Jar Relief Valve

Install the bell jar and connect the jar to the pressure gage calibrated in 1/2 p.s.i. graduations. Open supply oxygen valve slowly; when the pressure gage reaches 6 p.s.i., the relief valve should dump. If adjustment is necessary, remove the bell jar and either increase or decrease the pressure on the spring in the relief valve as required.

Calibration of Flowmeters and Gages

The flowmeters and gages are checked once a month. Connect a master flowmeter or pressure gage to the gage or flowmeter on the test stand that is being calibrated. Set the actual flows or pressures on the master gage or flowmeters. Record the indicated flows or pressures on the test stand gage or flowmeter. Make new correction cards if necessary.

CHAPTER 12

MAINTENANCE OF CO_2 TRANSFER EQUIPMENT

CO_2 transfer units are supplied to the Navy by the C-O-Two Fire Equipment Company of Newark, New Jersey, and the Walter Kidde Company, of Belleville, New Jersey. Both of these units and their related equipment are discussed in this chapter.

C-O-TWO TRANSFER UNIT

The transfer unit shown in figure 12-1 is furnished with the motor, stand, hose, and adapters. The cylinder stand and cylinder are not a part of the unit and must be provided locally. The motor-driven pump is designed with one cylinder, operating as a single-acting reciprocating type. It is manufactured from corrosion-resistant metal, and is mounted on a base support. Mounted on a sliding base, the motor can be adjusted to maintain the proper tension on the drive belt. The working pressure of the pump is approximately 3,500 p.s.i., and the unit is capable of transferring 80 percent or about 40 pounds of carbon dioxide from a fully charged 50-pound supply cylinder.

The pump head is fitted with a frangible safety disc designed to relieve pressure in the pump between 2,700 p.s.i. to 2,900 p.s.i. When the disc ruptures, a safety disc nut prevents any recoiling action. Ruptured discs are replaced easily.

The lower half or crankcase end of the pump is ruggedly constructed. The crankcase proper is made of close-grained nickel iron which is fitted with a well-baffled breather, oil filter, and drain plug. A positive oil seal is provided at the crankshaft. The crankshaft (center crank, counterbalanced construction) is made in one piece of drop-forced, heat-treated steel. At each end of the crankshaft is an extra large tapered adjustable roller bearing (single-row, antifriction type).

The connecting rod (shaped in the conventional I-section of automotive design) is also made of drop-forged, heat-treated steel. A shim-adjusted babbitted bearing is provided at the crankpin. The wristpin in the crosshead is of hardened polished steel and is furnished with a graphite bronze bushing, fitted with an oil groove. The crosshead, made of wear-resistant material, is also fitted with an oil groove.

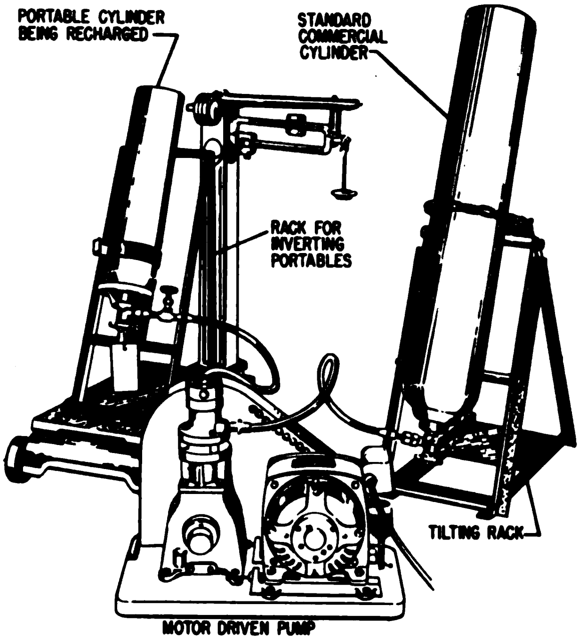

PORTABLE CYLINDER BEING RECHARGED
STANDARD COMMERCIAL CYLINDER
RACK FOR INVERTING PORTABLES
TILTING RACK
MOTOR DRIVEN PUMP

Figure 12-1.—C-O-Two transfer unit.

The lubricating system is the automatic-controlled splash type, while the oil flow is regulated by a fixed orifice in the oil trough.

Packing is provided at the entrance of the piston rod into the cylinder which is especially designed for tightness at high working pressures and for ease of adjustment.

The drive from the motor to the pump is a combination of V-belt drive pulley and gears. The small gear and large pulley are assembled together as a unit, and are both fitted with ball bearings and mounted on the idler shaft. Both pulleys are carefully balanced. A single guard is secured over both gears and pulleys.

The motor furnished as standard equipment is a 1-horsepower capacitor start induction type.

It is suitable for operation on either a 110- or 220-volt, single-phase, 60-cycle circuit. (A d-c motor is also available.) An enclosed control switch is located accessibly on the side of the motor.

ERECTION AND OPERATION INSTRUCTIONS.—After receiving the equipment examine components for damage. If the unit is damaged (under ordinary circumstances), do not attempt repairs. Return it to the supply officer who will direct its reshipment to the manufacturer.

Since the oil has been drained from the crankcase of the pump for shipment to field activities, make certain it is filled with a standard grade of SAE No. 30 lubricating oil before starting the unit. On pumps equipped with an oil filter plug and measuring stick, fill only to the upper groove on the stick. On a unit equipped with an oil cup on its side, having no measuring stick, fill to within 1/4 inch of the top of the cup. Other than the crankcase, there is only one other point on the pump that requires lubrication. This is on the shaft of the idler gear and pulley and is equipped with an alemite lubrication fitting. In spite of the fact that the pulley shaft has been prelubricated at the factory, it is advisable to relubricate the area with 2 or 3 applications (grease gun shots) of light cup grease before starting. The motor bearings contain enough grease to last for approximately 2 years, under average conditions.

Before running the pump, an electric circuit compatible to the motor must be found or be installed in the shop. Unless otherwise specified, motors are wired to operate on 110-volt, 60-cycle, single-phase circuits. When 220-volt, 60-cycle, single-phase current is available, the hookup of the motor should be rearranged so that it can be operated on this circuit. A 220-volt wiring diagram is shown on the nameplate of the motor. The plug on the end of the lead conducting the current to the motor from the power outlet should be equipped with a grounding wire, the third wire, usually containing a white covering. Regardless, whether a 3-pronged plug or a pigtail (coming out of the lead near a 2-prong plug, fitted with a clip) is used, the system to which this grounding wire is attached must also be grounded for the unit to be protected.

Always "run-in" a new pump, or one that has been idle for a long time. This action, accomplished with the CO_2 hoses disconnected, is performed as a check for lubrication to make certain that all parts are thoroughly treated. After turning off the pump, wipe off all excess lubricants.

Before pumping carbon dioxide, examine all line connections on both the inlet and outlet hoses. Make certain all connections between components are tight. This is important since carbon dioxide is stored under high pressure (approximately 850 p.s.i. at atmospheric temperature of 70° F.). Tighten connections with a wrench no larger than 12 inches, using a slow steady pull.

The transfer unit will pump carbon dioxide in its LIQUID PHASE ONLY. This is true of all CO_2 transfer units. Since the amount of liquid carbon dioxide contained in a fully charged cylinder varies with the pressure and temperature (a standard 50-pound cylinder contains approximately 40 pounds of carbon dioxide in its liquid phase and 12 pounds in it gaseous phase at atmospheric temperature 70° F.), it follows that the cooler the supply cylinder and the cylinder being recharged, the more efficient the operating of the transfer unit will be. Consequently, all cylinders should be kept in the coolest location possible. For the same reason, the time required to charge an empty cylinder increases with the temperature of the cylinders.

After all the liquid carbon dioxide is transferred from the supply cylinder which is approximately 80 percent of the net contents, the efficient transfer of CO_2 to the cylinder being recharged will cease. After this, another fully charged supply cylinder must be used to finish charging the cylinder to its full rated capacity. The majority of gas in the other supply cylinder can be used when recharging another EMPTY CYLINDER, as the gas will transfer itself under its own pressure until the pressure in both cylinders is equal. In this way, the most economical use of the contents of the supply cylinder is made.

To prevent expansion of carbon dioxide in the supply hose and consequently blocking the hose with CO_2 "snow," the valve should have an outlet opening of at least 1/8 inch in diameter, preferably 3/16 inch. Standard supply cylinders in 50-pound sizes are obtainable with or without a syphon tube. When ordering cylinders, specify the ones with a syphon tube. Those without syphons must be inverted during the transfer process.

Maintenance

ONCE EVERY MONTH.—Inspect the level of the oil in the crankcase and see that it is within the limits specified.

ONCE EVERY SIX MONTHS.—Lubricate the idler shaft with two or three applications of light cup grease; also, lubricate the gear teeth with a thin coating of the same grease. With a small brush, apply a light coating of vaseline to the piston rod. To do this, dip the brush in vaseline and hold the brush against the piston rod while rotating the gears manually until the piston rod has been coated completely. If necessary, tighten the packing at the piston stem. A special wrench is needed for this operation. Do not tighten excessively. Because of the design of the packing, it is necessary to make only a snug adjustment in order to have it hold tightly.

Keep the commutator of the motor clean. Under normal operating conditions, the commutator will require only occasional cleaning with a dry piece of nonlinting cloth. Never lubricate the commutator.

ONCE EVERY TWO YEARS.—Drain and refill the crankcase at least once every two years. The bearing housings of the motor which also need attention at this time should be cleaned and regreased by a qualified electrician.

TO REPLACE THE PISTON ROD PACKING.—The steps involved follow:

1. Remove the six bolts on top of the cylinder head. Remove the cylinder head.
2. Loosen hex nut (fig. 12-2) at the bottom of the piston rod.
3. Remove the three bolts which hold the cylinder body to the crosshead guide unit.
4. Raise the cylinder body and unscrew the piston rod from the crosshead so that it clears the base.
5. The piston rod packing is now in a position to be replaced. Remove the locknut from the piston rod, and then remove the piston rod packing nut.
6. When replacing the flanged type packing, remember that the packing nut serves only to hold the packing in place. Tightening the nut excessively WILL NOT increase its efficiency; and the packing nut should not be forced down tight enough to damage the packing flange.
7. After replacing the packing and packing nut, mount the cylinder body on the crosshead guide, making certain that the locknut is replaced on the piston rod before screwing it into the crosshead.
8. Screw the piston rod into the crosshead until the top edge of the piston packing is flush with the top of the cylinder body, with the crosshead in the uppermost position. (See fig.

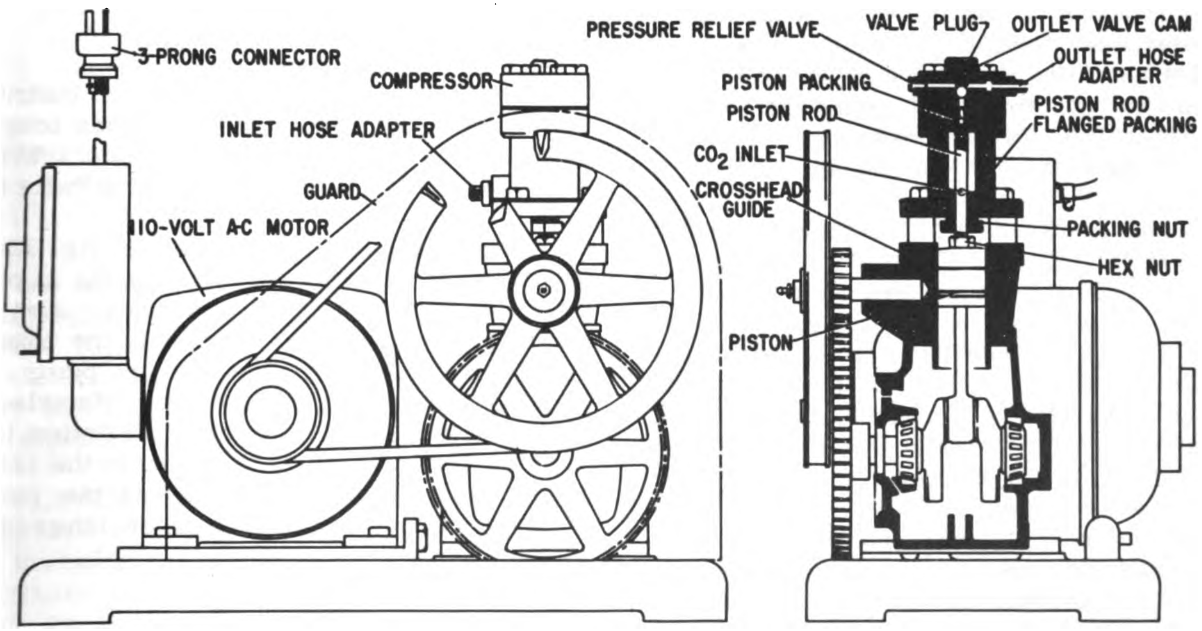


Figure 12-2.—Cross section of C-O-Two transfer unit.

12-2.) Check this adjustment by rocking the crank back and forth before tightening the locknut at the bottom of the piston rod.

9. Replace the piston head and tighten all the mounting bolts.

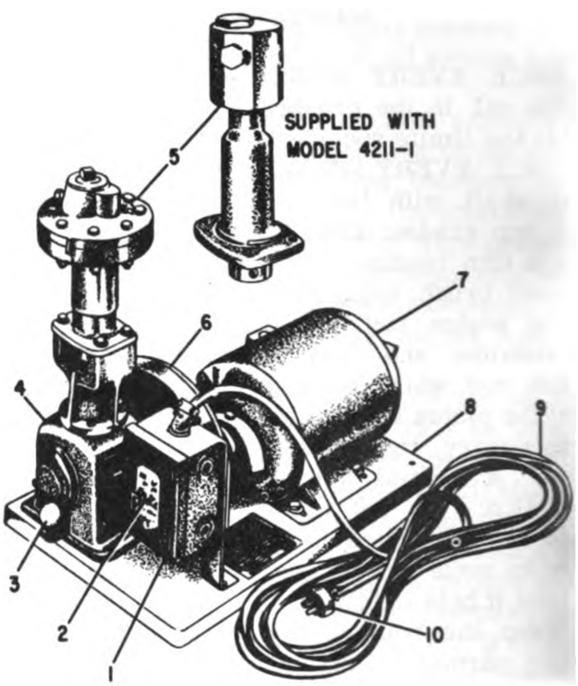
WALTER KIDDE TRANSFER UNIT

The Walter Kidde unit, like the C-O-Two unit, is designed and manufactured expressly for the purpose of transferring carbon dioxide in its liquid form from one cylinder to another. The unit is supplied complete with the necessary adapters, recharging valves, safety discs and bushings, nuts, bolts, and washers for making connections to the cylinders, and for minor adjustments to the unit. Pumps, models 4211 and 4211-1, are driven by a 3/4-horsepower motor and are equipped with a safety switch and lead fitted with a plug. Three-prong plugs and three-wire leads should be substituted for the ordinary two-wire, and two-prong arrangement. Pump models 4306 and 4306-1 are driven by a single-cylinder, four-cycle, air-cooled engine of 3/4 horsepower. Figure 12-3 illustrates the W.K. electric recharge unit, model 4211-1.

ERECTION AND OPERATIONAL INSTRUCTIONS.—Much of this information has been discussed for the C-O-Two transfer unit and need not be repeated; however, where a difference has been noted, it will be discussed.

After uncrating and inspecting the unit, make certain that the crosshead clears the packing nut. To do this, turn the master gear attached to the crankshaft. The mechanism must work freely.

Fill the crankcase with a standard grade of SAE 20 motor oil. CAUTION: DO NOT use any oil or grease in the cylinders or in any of the adapters of hose connections used to convey carbon dioxide. (Since this precaution was not specifically stated in the instructions for the adaptors connected to the other pumping unit, this is not meant to imply that oil or grease can be used in the adapters of the C-O-Two Company's equipment.) In any case, follow the manufacturer's instructions, adding or subtracting nothing, contained in their respective handbooks. Obviously however, where Bureau of Naval Weapons directives are concerned, the latter will take precedence over the manufacturer's instructions.



1. Multibreaker.
2. Power switch.
3. Oil filler cap.
4. Running gear assembly.
5. Compressor assembly.
6. Gear guard.
7. Motor.
8. Base.
9. Power cable.
10. Change to three-prong plug.

Figure 12-3.—Walter Kidde electric CO$_2$ transfer unit-model 4211.

Instead of a 12-inch wrench, W.K. instructions direct the use of one 10 inches long to tighten all hose-connections joints. While tightening, care should be taken not to twist the hose.

A strainer and strainer adapter (fig. 12-4) are inserted into the inlet line (at the supply cylinder) to the pump to prevent any dirt or turnings which may accumulate in the supply cylinder from blowing over into the pump and impairing the action of the valves. Knowledge of the function of the strainer in relation to a possible trouble area is important to the technician when attempting to analyze the cause of malfunctioning pump valves or other associated parts.

Maintenance

LUBRICATION.—The instruction book for this equipment simply recommends inspecting

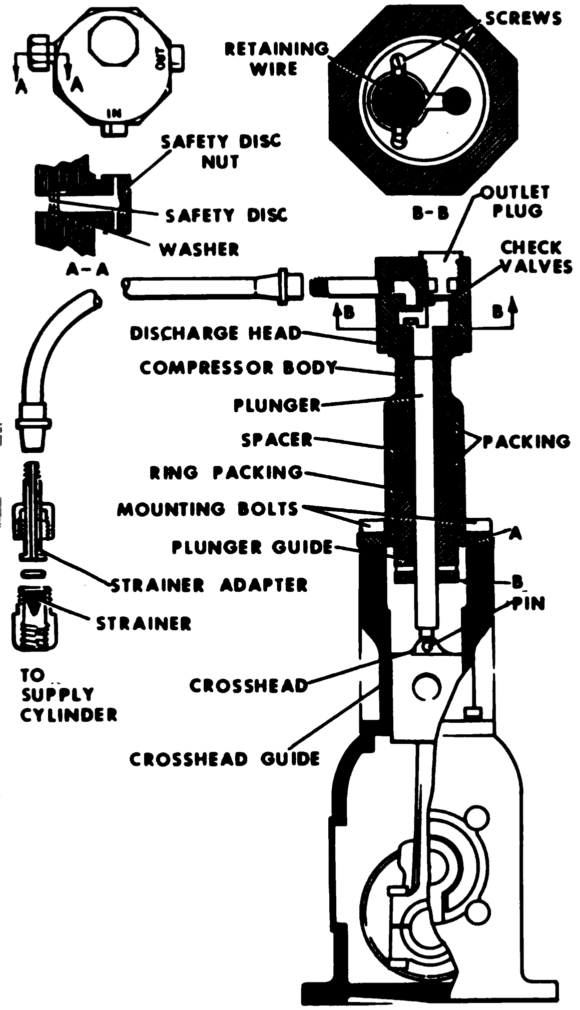


Figure 12-4.—Compressor assembly of the Walter Kidde CO_2 transfer unit.

he oil level in the crankcase periodically and hanging it as necessary. Here, experience with umps dictates the time of action. One can stablish and maintain a schedule compatible ith the experience gained through operating he equipment. The plunger packing needs no il.

PLUNGER PACKING.—Vapor leaks at this oint are sometimes impossible to overcome. n invisible vapor leak will not affect the perormance of the pump and no particular effort eed be made to eliminate a leak unless it eaches the point where it becomes visible. f a leak should develop at the lower end of the plunger, tighten the plunger guide, shown in figure 12-4, with a rod supplied (approximately 3/8" by 6"). Do not bind the plunger by tightening it too snugly. When it is no longer possible to adjust the tightness of the plunger guide, new packing should be inserted as follows:

1. Remove the compressor body from the frame by unscrewing the four bolts which hold the compressor body to the crosshead guide and remove the pin which holds the plunger to the crosshead.
2. Place the compressor body in a vise, remove the plunger guide and old packing. Insert only the two large pieces of packing and the spacer. Then insert the plunger guide and turn it down as far as possible to compress and form the packing around the plunger. This operation will cause the plunger to bind, but it can be freed by turning and working the plunger up and down a few times.
3. Remove the plunger guide and insert the small ring of the packing. Install so that the level fits the packing already in place and the plunger guide. Replace the plunger guide and turn it in until the maximum dimension between the body at point (A) and end of the plunger guide (B) is 1 3/16 inches. If the plunger guide is not screwed in sufficiently, the crosshead will strike the plunger guide. The plunger can be freed by working it back and forth several times.
4. Replace the compressor body, extending the plunger sufficiently so it can be lined up with the crosshead and the pin be replaced. After connecting the end of the plunger with the crosshead, which may have had to be moved to its top position in order to accomplish the connection, tighten the bolts securely. Turn the master gear for several revolutions by hand to be certain the crosshead does not strike the plunger guide.

SAFETY DISC.—Figure 12-4 illustrates the safety disc arrangement located in the discharge body. The method of removal and replacement of the safety disc is self evident in the illustration; however, never use a disc that is stronger or weaker (tensile strength capacity) than specified.

CLEANING.—Recharging pump connections should be kept free of foreign matter. If a decrease is noted in the amount of carbon dioxide transferred (should be approximately 80 percent of the supply cylinder), remove the two check valves (fig. 12-4) in the compressor head and clean. To do this, remove the discharge head body (right-hand thread). Then remove two screws and retaining wire. The inlet check will then be accessible. The outlet check can be removed by unscrewing the plug. Clean both checks and seat thoroughly.

The strainer on the inlet line (from the supply cylinder) should be cleaned frequently for maximum efficiency of the pump.

Periodically tighten all bolts on the compressor head and frame.

APPENDIX I

FILM LIST

FILM NO.	TITLE	RUNNING TIME
MN-6915A	High Altitude, High Speed Flight Problems—Physiological Effects	23 minutes
	Explains operation of oxygen equipment, cabin pressurization and ventilation, g-suits, and escape methods. Applicable to chapters 6, 7, and 8.	
MA-6920	Uses of Oxygen in Aviation	22 minutes
	Shows uses and effects of oxygen at high altitudes, effects oxygen has on the human body, etc. Applicable to chapters 7 and 8.	
MA-9268C	Packing of Parachutes—G-13 Cargo Parachute	10 minutes
	Teaches initial layout, proper layout, folding gores, folding and stowing parachute in packtray, and lacing pack assembly. Applicable to chapter 5.	
MN-9299	Escape by Parachute	20 minutes
	Describes the various types of parachutes used by Navy. Applicable to chapter 3.	
MN-8323A	Full Pressure Suit—Mk IV	19 minutes
	Demonstrates how to put on, adjust, and take off the full pressure suit. Explains operation of suit at various altitudes. Applicable to chapter 6.	
MN-8364A	Survival and Safety Equipment— Lq. Ox. Converters.	12 minutes
	Shows how converters work, how the liquid is stored, converted to gas, and controlled within operating limits. Applicable to chapter 11.	

FILM NO.	TITLE	RUNNING TIME
MN-8760A	Helicopter Rescue at Sea	21 minutes
	Describes how the potential survivor can cooperate in his own rescue by helicopter by knowing what to do. Applicable to chapter 3.	
MV-9404P	Survival Training—Traps and Snares	13 minutes
	Shows some important approaches to selecting the appropriate location and type trap or snare. Demonstrates some traps and snares in varying situations. Applicable to chapter 3.	
MV-9407	Deep Sea Survival	27 minutes
	Factual stories of courage portray the violent conditions to be faced in survival at sea. They also prove that airmen can survive relatively long periods at sea provided they follow approved survival methods and have the will and endurance to live. Applicable to chapter 3.	

APPENDIX II

QUALIFICATIONS FOR ADVANCEMENT IN RATING

PARACHUTE RIGGER (PR)

(Through Change 19)

GENERAL RATING

SCOPE

Parachute Riggers: Inspect, maintain, and repair parachutes, survival equipment, and flight and protective clothing and equipment; pack and rig parachutes; pack and equip liferafts; repair and test oxygen regulators and liquid oxygen converters removed from aircraft; fit and maintain oxygen masks, flight clothing, antiexposure suits and anti-g suits; test and service pressure suits; operate and maintain carbon dioxide and liquid and gaseous oxygen shop transfer and recharge equipment; operate and repair sewing machines; test safety belts and shoulder harnesses removed from aircraft; and supervise operation of parachute lofts.

SERVICE RATINGS

None.

PATH OF ADVANCEMENT TO LIMITED DUTY OFFICER

Parachute Riggers advance to Limited Duty Officers, Aviation Operations.

NAVY ENLISTED CLASSIFICATION CODES

See Manual of Navy Enlisted Classifications, NavPers 15105-B.

QUALIFICATIONS FOR ADVANCEMENT IN RATING

1. Qualifications for advancement to a higher rate include the qualifications of the lower rate or rates in addition to those stated for the higher rate.
2. Practical factors will be completed before recommendation for participation in the advancement examination. (Bureau of Naval Personnel Manual, NavPers 15791-A, Articles B—2326 and C—7201.)
3. Knowledge factors and knowledge aspects of practical factors will form the basis for questions in the written advancement examination.

Qualifications for Advancement in Rating	Applicable Rates
	PR
A. SAFETY	
1.0 PRACTICAL FACTORS	
1. Observe safety precautions when working in parachute lofts and shops, handling oxygen and carbon dioxide, and operating sewing machines	3
2. Observe safety precautions in use, handling, and storage of flammable cements, solvents, and thinners	2
3. Observe safety precautions in use of oxygen shop transfer equipment and in handling liquid and gaseous oxygen.	1
4. Inspect work areas, tools, and equipment to detect potentially hazardous and unsafe conditions and take appropriate corrective action.	C
2.0 KNOWLEDGE FACTORS	
None.	
B. PARACHUTES	
1.0 PRACTICAL FACTORS	
1. Inspect and pack personnel parachutes, including those integrated with ejection seats; attach and rig equipment, such as pararaft kits and oxygen bailout units; make entries on parachute record and history cards. (Personnel in the PR rating are also responsible for repacking ejection seat drogue chutes but this is not an advancement requirement.)	3
2. Unpack, wash, and dry parachutes	3
3. Inspect parachute material for stains and deterioration	3
4. Make minor repairs to parachutes and component parts	3
5. Instruct plane captains, pilots, and aircrewmen in proper care, handling, and stowage of parachutes. .	2
6. Test and adjust automatic parachute actuators. . . .	1
7. Measure temperature and humidity in parachute dry lockers and storage rooms	1
8. Instruct in the procedures for parachute landings in high winds, trees, and water	C
9. Demonstrate aircraft emergency escape procedures and use of parachutes under simulated conditions	C
2.0 KNOWLEDGE FACTORS	
1. General arrangement and facilities of parachute lofts ashore and afloat.	3
2. Types, component parts, construction, and operation of personnel parachutes.	3
3. Types and operating principles of automatic parachute actuators	2

Qualifications for Advancement in Rating	Applicable Rates
	PR
2.0 KNOWLEDGE FACTORS—Continued	
4. Procedures for removing stains from parachute material	2
5. Temperature and humidity limitations for parachute dry lockers and storage rooms	1
6. Identifying characteristics and proper treatment for various causes of stains in parachute material	1
7. Purposes and operating principles of drogue, cargo, target drone, and other types of nonpersonnel parachutes	C
C. FABRIC WORK	
1.0 PRACTICAL FACTORS	
1. Hand sew, stitch, and tack material	3
2. Install and replace standard snap fasteners, grommets, slide fasteners, and speedy rivets	3
3. Inspect and proof load safety belts, automatic lapbelts, and shoulder harnesses removed from aircraft. (Safety belts, automatic lapbelts, and shoulder harnesses are removed and installed in aircraft by personnel in the AM rating.)	3
4. Operate standard sewing machines	3
5. Repair slide fasteners	2
6. Lubricate sewing machines and make minor adjustments	2
7. Cold patch rubberized material	2
8. Make fabric asemblies	2
9. Develop and lay out patterns from drawings, blueprints, and photographs	1
10. Determine causes of sewing machine malfunctions; repair and replace parts	C
2.0 KNOWLEDGE FACTORS	
1. Types and general characteristics of fabrics, tapes, webbings, fasteners, needles, thread, and other material used in fabric work	3
2. Types and uses of seams and stitching patterns	3
3. Operating principles of standard sewing machines	3
4. Types and application of fabric patches	2
5. Procedures for removing stains from fabric materials	2
6. Symbols and terms used on drawings and blueprints for fabric work	1
7. Specifications, characteristics, and uses of fabrics, tapes, webbings, thread, hardware, and other materials used in fabric work and allowable substitutes	C
D. FLIGHT AND PROTECTIVE CLOTHING AND EQUIPMENT	
1.0 PRACTICAL FACTORS	
1. Inspect and test lifevests and attached equipment	3
2. Inspect and clean oxygen masks	3
3. Remove and replace components of oxygen mask assemblies including mask-mounted oxygen regulators	3

Qualifications for Advancement in Rating	Applicable Rates
	PR
1.0 PRACTICAL FACTORS—Continued	
4. Prepare required records and reports of flight and protective clothing and equipment inspections and maintenance	3
5. Patch lifevests and antiexposure suits	2
6. Repair flight clothing	2
7. Fit integrated torso harness suits	2
8. Fit and repair antiexposure suits	2
9. Fit and adjust helmets and liners; install earphones and microphones. (Earphones and microphones are maintained by personnel in the AT rating.)	2
10. Fit and adjust anti-g suits. (Anti-g systems, except the suit, are maintained by personnel in the AM rating.)	1
11. Operate portable pressure suit leakage test kits; test pressure suits and related components. (Full and partial pressure suits are fitted under the direction of flight surgeons and aviation physiology training units.)	1
12. Fit and modify oxygen masks	C
13. Demonstrate use of flight and protective clothing and equipment under simulated conditions	C
2.0 KNOWLEDGE FACTORS	
1. Use and application of fire retardant compounds for flight clothing	2
2. Regulations governing changes and repairs to flight and protective clothing and equipment	2
3. Components and principles of operation of full pressure suits	1
E. SURVIVAL EQUIPMENT	
1.0 PRACTICAL FACTORS	
1. Inspect, test, equip, and pack liferafts; replace carbon dioxide cylinders. (Liferaft ejection systems in aircraft are maintained by personnel in the AM rating. Emergency radio signaling units are delivered to the electronic shop for maintenance or exchange by personnel in the AT rating.)	3
2. Operate carbon dioxide recharge equipment	3
3. Patch holes and tears in liferafts	2
4. Demonstrate use of liferafts and equipment	2
5. Maintain carbon dioxide recharge equipment	1
6. Assemble, pack, and rig airdrop survival kits and containers	C
2.0 KNOWLEDGE FACTORS	
1. Types, construction, and operation of liferafts	3
2. Principles of operation of carbon dioxide cylinder components used in liferafts	2

Qualifications for Advancement in Rating	Applicable Rates
	PR
2.0 KNOWLEDGE FACTORS—Continued	
3. Construction of various types of liftwebs and sling assemblies for use on cargo to be dropped with aerial delivery parachutes	C
F. OXYGEN EQUIPMENT	
1.0 PRACTICAL FACTORS	
1. Operate and maintain liquid and gaseous oxygen shop transfer equipment. (Personnel in the AM rating service, handle, and maintain liquid and gaseous oxygen transfer trailers.)	1
2. Shop test aircraft liquid oxygen converters; repair or replace components as necessary. (Converters are removed and installed in aircraft by personnel in the AM rating and delivered to the oxygen shop for test, repair, or exchange.)	1
3. Test oxygen for contamination, using water vapor indicators, halide detectors, and purity analyzers	1
4. Test and repair oxygen regulators. (Includes mask-mounted, aircraft-mounted, and pressure-suit regulators. Aircraft-mounted regulators are removed and installed in aircraft by personnel in the AM rating and delivered to the oxygen regulator shop for test, repair, or exhange.)	1
5. Prepare appropriate calibration and flow charts for testing oxygen regulators and liquid oxygen converters	C
6. Maintain oxygen regulator test stands and liquid oxygen converter test stands	C
2.0 KNOWLEDGE FACTORS	
None.	
G. ADMINISTRATION	
1.0 PRACTICAL FACTORS	
1. Inventory and order equipment, spare parts, and material	1
2. Maintain current loft and shop files of applicable technical publications, directives and manuals	1
3. Prepare reports of test and repair of oxygen regulators	1
4. Maintain loft and shop records of packing, inspection, test, and repair of equipment and material; prepare appropriate reports	1
5. Use NAVAER Publications Index to identify and order technical publications, directives, and manuals	1
6. Organize and administer a parachute loft	C
7. Plan, schedule, and direct work assignments in a parachute loft	C

Qualifications for Advancement in Rating	Applicable Rates
	PR
1.0 PRACTICAL FACTORS—Continued	
8. Interpret and apply bulletins and technical directives	C
9. Prepare reports for survey of material and equipment	C
10. Instruct and supervise personnel in use of parachute loft equipment and facilities and maintenance techniques; maintain quality control of work performed	C
11. Prepare for advanced-base or forward-area operation by estimating material, equipment, and manpower requirements	C
2.0 KNOWLEDGE FACTORS	
None.	

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